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ABSTRACT

This guide provides job-related tasks, performance objectives, performance guides, resources, teaching activities, evaluation standards, and criterion-referenced measures in three units of a welding course. Through the curriculum content of the welding course, the guide helps teachers lead students through the learning process, including the psychomotor, cognitive, and affective domains. The three units comprising the curriculum guide cover the following topics: setting up welding equipment, performing burning/welding activities, and performing related duties. Each unit is divided into performance objectives. For each objective are listed a task, standard of performance, source of standard, conditions of performance, enabling objectives, resource, teaching activities, criterion-referenced questions and answers, a practical application, and a checklist for evaluating the student's performance of the application. Appendixes to the guide provide a duty/task list, definitions, lists of tools/equipment/work aids, a 74-item state-of-the-art literature list, and a 7-item bibliography compiled by the South Carolina Writing Team that developed the curriculum guide. (KC)

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V-TECS GUIDE
FOR
WELDING

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INTRODUCTION

A V-TECS Guide is an extension or a continuation of one or more V-TECS Catalogs. The V-TECS Catalog is a composition of duties, tasks, performance objectives, and performance guides which deal with the psychomotor aspect of an occupation. The catalog can be considered the blueprint of an occupation.

The catalog serves as the foundation for the V-TECS Guide. Experience has shown that the art of learning can be taught while teaching subject matter. A V-TECS Guide provides an efficient method for this process. The Guide addresses the three domains of learning: psychomotor, cognitive, and affective. The following is a brief explanation of each.

Psychomotor

Manipulative skills, such as sharpening a pencil and making a bulletin board display, are representative of activities that are psychomotor in nature. These tasks are identified in a catalog and grouped by duties and objectives. Each performance objective has a performance standard which must be met to demonstrate student proficiency in the manipulative aspect of the task.

Cognitive

Cognition is the mental process by which knowledge is acquired. To perform psychomotor tasks, students must think. Effective thinking is necessary for successful performance of job tasks. Students gain cognition through real and vicarious experiences. This guide enables the instructor to provide decision-making opportunities for students, thus developing their cognitive skills.

Affective

The affective domain deals with attitudes, interests, and values development. Desirable behavior is the learning outcome of the affective domain. This guide presents activities created to promote an understanding of self and others in a working environment. The instructor is encouraged to use the activities to stress how attitudes, values, and goal attainment influence working relationships and productivity.

USE OF V-TECS GUIDE

A V-TECS Guide is designed to provide job-relevant tasks, performance objectives, performance guides, resources, teaching activities, evaluation standards, and criterion-referenced measures. It may be used with any teaching method the instructor chooses. Although a guide contains suggestions for specific classroom activities for each identified task, teachers are encouraged to be creative in adapting the material to meet the particular needs of their students.

SETTING UP WELDING EQUIPMENT

DUTY SETTING UP WELDING EQUIPMENT

PERFORMANCE OBJECTIVE 1

TASK

Set up air-carbon arc cutting/gouging equipment.

STANDARD OF PERFORMANCE OF TASK

The workpiece and guides must be secured; leads must make contact; the hoses must be unobstructed; the electrode must extend no more than five inches from the air jets.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Air-carbon arc cutting/gouging torch
Air hose
Air compressor
Constant current DC power supply
Clamps
Electrode
Portable screens
Power leads

ENABLING OBJECTIVES

1. Demonstrate knowledge of safety practices when working with arc welding equipment.
2. Select and use basic tools correctly.
3. Identify terminology associated with DC power supply.
4. Secure workpiece to bench.

RESOURCES

1. Kennedy. **Welding Technology**. pp. 408-12.
2. Althouse et al. **Modern Welding**. pp. 22, 399-406.

TEACHING ACTIVITIES

1. Read and discuss resource material.
2. Have students identify air-carbon arc cutting/gouging equipment.
3. Demonstrate how to set up air-carbon arc cutting/gouging equipment.
4. Have students identify various sizes of carbon electrodes and corresponding current ranges.
5. Have students practice setting up air-carbon arc cutting/gouging equipment.

PERFORMANCE OBJECTIVE 1

CRITERION-REFERENCED MEASURE

Questions

1. How should the operator's hand be protected during a manual carbon arc cutting operation?

2. Is the air turned on **before** or **after** the arc is produced?

3. What is the correct amperage range for a 1/4" carbon arc rod?
   a. 80 -150 amps
   b. 150 - 350 amps
   c. 400 - 800 amps
   d. 600-1000 amps

4. The air is fed to the air carbon arc cutting torch jet at ________ to ________ psig to obtain a satisfactory cut.
   a. 60 -100
   b. 10 - 50
   c. 100-200
   d. 200-300

Answers

1. A gauntlet type glove should be worn.
2. before
3. b.
4. a.

Practical Application

Have students set up air-carbon arc cutting/gouging equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 1 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 1

SETTING UP AIR-CARBON ARC CUTTING/GOUGING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT	Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Secured workpiece to bench as needed.		
2. Connected ground lead to bench or workpiece and to power source terminal.		
3. Connected welding lead to positive power source terminal.		
4. Connected cable and air hose to electrode holder.		
5. Connected to power source.		
6. Checked that hoses were not kinked or obstructed.		
7. Installed electrode in holder so that electrode tip extended no more than five inches from air jets.		
8. Secured cutting guide so that it was insulated from workpiece as needed.		
9. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

DUTY SETTING UP WELDING EQUIPMENT

PERFORMANCE OBJECTIVE 2

TASK

Set up GMAW (MIG) welding equipment.

STANDARD OF PERFORMANCE OF TASK

The inert gas cylinder must be secured, vented, and free from contamination or gas leaks; the flowmeter must be attached to the cylinder, free from leaks, and backed off so that no inert gas goes to the torch assembly when cylinder is first opened; the heater-vaporizor must be installed; welding wire must be able to automatically feed through the torch when the mechanism is operated; the workpiece must be secured; leads must make contact; the portable screens must be in place.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

AC/DC power source
Clamp
Inert gas cylinder
Inert gas flowmeter gauge
Combination tank wrench
Hoses
MIG torch assembly
Portable screens
Power leads
Welding wire
Wire feeder
Heater-vaporizor

ENABLING OBJECTIVES

1. Demonstrate safe work practices.
2. Demonstrate knowledge of basic welding terminology, such as AC/DC, amperage, etc.
3. Select the proper basic tools.

RESOURCES

1. Kennedy. **Welding Technology**. Chapter 22.
2. Althouse et al. **Modern Welding**. Chapters 11 and 13.
3. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 17.

TEACHING ACTIVITIES

1. Read and discuss resources listed.

PERFORMANCE OBJECTIVE 2

TEACHING ACTIVITIES (Continued)

2. Have students identify gas metal arc welding (GMAW) equipment.
3. Demonstrate how to set up GMAW equipment.
4. Have students identify various types of shielding gases and electrode sizes.
5. Have students practice setting up GMAW equipment.

CRITERION-REFERENCED MEASURE

Questions

1. Most GMAW current is
   a. DCRP.
   b. DCSP.
   c. AC.
   d. DCSP or AC.

2. The use of AC current is not recommended for MIG welding because
   a. penetration is too shallow.
   b. the danger of burn-through is too great.
   c. welding speed is too slow.
   d. wire burn-offs are usually unequal.

3. Spray transfer is not too practical for welding
   a. light gauge metal.
   b. heavy metal plates.
   c. non-ferrous metals.
   d. joints with irregular root openings.

4. MIG welding produces deeper and narrower beads than shielded metal arc welding (SMAW). True or False?

5. For a specific voltage setting, a high wire feed will result in a long arc. True or False?

Answers

1. a.
2. d.
3. a.
4. True
5. False

Practical Application

Have students set up GMAW (MIG) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 2 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 2

SETTING UP GMAW (MIG) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Insured that inert gas cylinder was secured in position.		
2. Removed protective cap.		
3. Opened and closed cylinder valve quickly to vent any foreign material from outlet port.		
4. Insured that flowmeter fittings were clean.		
5. Connected heater-vaporizer to gas cylinder and plugged into power source.		
6. Connected flowmeter to cylinder's outlet port (or to heater).		
7. Adjusted position of flowmeter and tightened fittings.		
8. Backed-off flowmeter adjusting screw.		
9. Fully opened main cylinder valve.		
10. Attached inert gas hose to flowmeter.		
11. Checked for leaks.		
12. Installed welding wire into wire feed.		
13. Threaded welding wire through feeder drive wheels and torch cable.		
14. Connected wire feeder to power supply as needed.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 2

SETTING UP GMAW (MIG) WELDING EQUIPMENT

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
15. Secured workpiece to bench as needed.		
16. Connected ground lead to bench/workpiece and power source terminal.		
17. Connected welding lead to power source terminal.		
18. Connected to power source.		
19. Checked that hoses were not kinked or obstructed.		
20. Checked that portable screens were in place.		
21. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature ________________ Date

DUTY SETTING UP EQUIPMENT

PERFORMANCE OBJECTIVE 3

TASK

Set up oxyacetylene cutting/welding equipment.

STANDARD OF PERFORMANCE OF TASK

The oxygen and acetylene cylinders must be secured, vented, and free from contamination or leaks; each regulator must be attached to its respective cylinder, free from leaks, and backed off so that no oxygen or acetylene goes to the torch assembly when cylinders are first opened; the key wrench must remain on the acetylene cylinder valve while in use; the oxygen cylinder valve must be opened fully; the acetylene cylinder valve must be opened 1/4 to 1/2 turn; the oxygen and acetylene hoses must be attached to their respective torch fittings, unobstructed, and free from leaks.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Acetylene cylinder
Acetylene hoses
Acetylene regulator
Combination tank wrench
Key wrench

Oxygen cylinder
Oxygen hoses
Oxygen regulator
Torch assembly

ENABLING OBJECTIVES

1. Demonstrate safe work practices.
2. Demonstrate awareness of potential danger of oxyacetylene equipment if not handled properly.
3. Select and use basic tools.
4. Read Information Sheet 1.
5. Read Teacher Information Sheet 2.

RESOURCES

1. Kennedy. **Welding Technology.** Chapter 1.
2. Althouse et al. **Modern Welding.** Chapters 5 and 6.
3. Jeffus and Johnson. **Welding: Principles and Applications.** Chapter 4.

TEACHING ACTIVITIES

1. Read and discuss any resource listed.
2. Have students identify oxyacetylene equipment.

TEACHING ACTIVITIES (Continued)

3. Demonstrate and explain safety procedures for securing cylinders, etc.
4. Demonstrate how to set up oxyacetylene equipment.
5. Have students practice setting up oxyacetylene equipment.

CRITERION-REFERENCED MEASURE

Questions

1. Cylinders should always be transported and used in the upright position. True or False?

2. Oxygen and acetylene hoses have right and left hand threads and must be connected to the proper places. True or False?

3. The cylinder valve is cracked to
   a. let off excess pressure.
   b. remove foreign particles.

4. It is correct to use light oil or grease occasionally when lubricating oxyacetylene equipment. True or False?

5. The maximum safe amount of acetylene pressure to be used is
   a. 10 psig.
   b. 15 psig.
   c. 20 psig.
   d. 30 psig.

6. The oxygen cylinder is considered a high or low pressure cylinder?

Answers

1. True
2. True
3. b.
4. False
5. b.
6. high

Practical Application

Have students set up oxyacetylene cutting/welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 3 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 3

SETTING UP OXYACETYLENE CUTTING/WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Insured that cylinders were secured in position.		
2. Removed protective caps.		
3. Opened and closed cylinder valves quickly to vent any foreign material.		
4. Attached regulators to cylinder valves. CAUTION: All oxygen fittings are right hand threads; all fuel gas fittings (i.e. acetylene) are left hand threads.		
5. Backed off adjusting screws on each regulator.		
6. Attached hoses to respective regulators.		
7. Attached torch assembly to the other end of the hoses.		
8. Insured that torch needle valves were turned off.		
9. Opened acetylene cylinder valve 1/4 to 1/2 turn, leaving key wrench on acetylene cylinder valve.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 3

SETTING UP OXYACETYLENE CUTTING/WELDING EQUIPMENT

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
10. Fully opened oxygen cylinder valve.		
11. Checked for leaks.		
12. Performed all work in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature **Date**

TEACHER INFORMATION SHEET 1
(PERFORMANCE OBJECTIVE 3)

SAFETY PRECAUTIONS FOR OXYGEN AND ACETYLENE
THE DO'S

1. Be very careful when moving any oxygen or acetylene cylinder.
2. Keep oxygen away from oil and grease.
3. Crack cylinder valve before attaching regulator. (Cracking means opening the valve on a cylinder a little then closing it quickly. This blows out dirt.)
4. Open valve on cylinder slowly after regulator is attached.
5. Be sure all connections are clean and tight.
6. Check all connections before lighting the torch.
7. When the regulator is not in use, the adjusting screw should be turned out until diaphragm is free.
8. When the torch flashes back or is burning on the inside, turn needle valve off immediately. (The tip is too close to the work, the tip is not clean, or the oxygen or acetylene is not set to the correct welding or cutting pressure.)
9. Protect the hose from rupture or mechanical damage.
10. Close the cylinders and release the pressure from the regulators and hose when work is completed.
11. Extra tips should be put away when not in use. Never put them in a drawer or with other tools. This may damage the seat of the tip.
12. Use the right size tip for cutting or welding.
13. Turn the oxygen cylinder valve all the way open - this locks the valve.
14. Keep the cylinders in an upright position.
15. Mark the cylinders that have been used - "EMPTY" or "MT."
16. Place the welding tip so that it points to the side of the torch to which the acetylene hose is attached.
17. Close valves on the cylinders and release pressure from regulator and hose when work is completed, or at the end of day.

TEACHER INFORMATION SHEET 2
(PERFORMANCE OBJECTIVE 3)

SAFETY PRECAUTIONS FOR OXYGEN AND ACETYLENE
THE DON'TS

1. Do not use oil or grease on any oxygen or acetylene connections. Oil and oxygen will ignite.
2. Never open tank valves unless the regulator valves are closed. (When the regulator is not in use, the adjusting screw should be turned out until diaphram is free.)
3. Never open the valves on the cylinders with a hammer.
4. Never hammer on oxygen or acetylene regulators.
5. Do not light a torch with a match or open flame. Use flint striker provided.
6. Before lighting torch, be certain that hose, tanks, or any flammable material will not be exposed to heat, flame, or sparks.
7. Beware of high acetylene pressures! Never use acetylene gas when the pressure is greater than 15 lbs. per square inch. (Acetylene gas which has been compressed to more than 15 lbs. becomes highly explosive.)
8. Never turn the regulator screw in tightly against the regulator. This spoils the diaphragm. If hose pressure drops, check tank pressure at regulator as tank is probably empty.
9. Do not hold welding or cutting tip too close to the work. This will cause a flash-back to the torch.
10. Never use a tip that becomes hot.
11. Do not use a torch that leaks.
12. Never leave the torch burning unattended.
13. Do not leave torch valve open.
14. Never cut or weld too close to concrete. Put fire brick next to the work.
15. Do not use the torch for a hammer, crowbar, wedge, or for any purpose other than welding.
16. Do not adjust, alter, change, build, or do any experimental work on cylinders, regulators, torches, or any other gas equipment.
17. Never attempt to weld a closed or jacketed tank, vessel, or container without a vent for air. Great care should be taken not to allow gas in the tank. If for any reason gas gets in the tank, aerate the tank.
18. Do not have butane lighter or book matches in shirt, pants, or jacket pockets.

DUTY SETTING UP WELDING EQUIPMENT

PERFORMANCE OBJECTIVE 4

TASK

Set up oxygen-arc cutting/gouging equipment.

STANDARD OF PERFORMANCE OF TASK

The oxygen cylinder and regulator must be vented and free from contamination or leaks; the regulator must be adjusted to the required pressure; the workpiece and guides must be secured; the leads must make contact with the welding lead attached to the negative power source terminal; the hoses must be unobstructed; the protective screens must be in place.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

AC/DC power source
Oxygen-arc cutting/gouging torch
Clamps
Combination tank wrench
Electrode
Metal catch-box

Oxygen cylinder
Oxygen regulator
Oxygen hose
Portable screens
Power leads

ENABLING OBJECTIVES

1. Know safe work practices for working with oxygen-arc cutting/gouging equipment.
2. Be familiar with basic welding terminology.
3. Identify and select proper tools.

RESOURCES

1. Kennedy. **Welding Technology**. Chapter 9.
2. Althouse et al. **Modern Welding**. Chapters 5 and 6.

TEACHING ACTIVITIES

1. Read and discuss resources listed.
2. Have students identify arc cutting and gouging equipment.
3. Demonstrate how to set up oxygen-arc cutting/gouging equipment.
4. Have students practice setting up oxygen-arc cutting/gouging equipment.

PERFORMANCE OBJECTIVE 4

CRITERION-REFERENCED MEASURE

Questions

1. The current settings for oxygen-arc cutting are
   a. approximately the same as for welding.
   b. much higher.
   c. much lower.

2. For oxygen-arc cutting, the electrode is usually
   a. flat and wide.
   b. fat and round.
   c. a narrow diameter electrode.

3. The oxygen-arc cutting and gouging process can cut or gouge which of the following metals?
   a. stainless
   b. aluminum
   c. bronze or brasses
   d. cast iron
   e. all of the above

4. The equipment required for this process may be either AC or DC welding machine. True or False?

Answers

1. a.
2. c.
3. c.
4. True

Practical Application

Have students set up oxygen-arc cutting/gouging equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 4 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 4

SETTING UP OXYGEN-ARC CUTTING/GOUGING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**RATING**	
	Satisfactory	**Unsatisfactory**
1. Insured that oxygen cylinder was secured in position.		
2. Removed protective cap.		
3. Opened and closed cylinder valve quickly to vent any foreign material from outlet port.		
4. Insured that regulator fittings were clean.		
5. Connected regulator to cylinder's outlet port. CAUTION: All oxygen fittings are right-hand threads.		
6. Adjusted position of regulator and tightened using the combination tank wrench.		
7. Backed-off regulator adjusting screw to release pressure on the regulator's diaphragm.		
8. Fully opened main cylinder valve.		
9. Adjusted oxygen pressure for application (usually between 75 and 95 PSI).		
10. Attached oxygen hose to regulator.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 4

SETTING UP OXYGEN-ARC CUTTING/GOUGING EQUIPMENT

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
11. Attached oxygen hose to cutting torch.		
12. Checked for leaks.		
13. Secured workpiece to bench as needed.		
14. Connected ground lead to bench or workpiece and to power source terminal.		
15. Connected welding lead to negative power source terminal.		
16. Plugged in power source.		
17. Checked that hoses were not kinked or obstructed.		
18. Installed electrode in holder.		
19. Checked that portable screens were in place.		
20. Secured cutting guide so that it was insulated from workpiece as needed.		
21. Performed all work in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature **Date**

DUTY SETTING UP WELDING EQUIPMENT

PERFORMANCE OBJECTIVE 5

TASK

Set up plasma-arc cutting/welding equipment.

STANDARD OF PERFORMANCE OF TASK

The inert gas cylinders must be secured, vented, and free from contamination or leaks; the regulators must provide the proper pressures and be free from leaks; the cooling system must provide sufficient cooling and be free from leaks; the leads must make contact; the inert gas hoses must be unobstructed; the workpiece and insulated guides must be secured in position; the portable screens must be in place.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Clamps
Combination wrench
DC power source
Inert gas cylinders
Inert gas hoses
Inert (plasma) gas regulator
Inert (shielding) gas regulator
Plasma-arc cutting/gouging torch
Portable screens
Power leads
Repair/Maintenance kit #2
Tungsten electrodes
Coolant adapter/hoses

ENABLING OBJECTIVES

1. Know and demonstrate safe work practices.
2. Be familiar with basic welding terminology.
3. Select and use basic tools.

RESOURCES

1. Kennedy. **Welding Technology**. Chapter 17.
2. Althouse et al. **Modern Welding**. pp. 26, 392-396, 406-407, 470-471.
3. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 20.

TEACHING ACTIVITIES

1. Read and discuss resources listed.
2. Have students identify plasma-arc cutting and welding equipment.

PERFORMANCE OBJECTIVE 5

TEACHING ACTIVITIES (Continued)

3. Demonstrate how to set up plasma-arc cutting and welding equipment.
4. Have students identify various types of metals that plasma-arc cuts and welds.
5. Have students practice setting up plasma-arc cutting and welding equipment.

CRITERION-REFERENCED MEASURE

Questions

1. Plasma-arc cutting and welding equipment can be used on ferrous as well as non-ferrous metals. True or False?

2. What is plasma?
   a. a liquid that can cut or weld metal
   b. a flame that can cut or weld metal
   c. a gas that has been heated at least to a partially ionized condition, enabling it to conduct an electrical current

3. Using a plasma process spreads the heat evenly throughout the metal. True or False?

4. Sometimes plasma is known as the
   a. first state of matter.
   b. second state of matter.
   c. third state of matter.
   d. fourth state of matter.

Answers

1. True
2. c.
3. False
4. d.

Practical Application

Have students set up plasma-arc cutting/welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 5 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 5

SETTING UP PLASMA-ARC CUTTING/WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Insured that inert gas cylinder(s) were secured in position.		
2. Removed protective cap(s).		
3. Opened and closed cylinder valve(s) quickly to vent any foreign material from outlet port(s).		
4. Insured that regulator fitting(s) were clean. CAUTION: Inert gas equipment must not be interchanged.		
5. Connected regulator(s) to cylinder's outlet port(s).		
6. Adjusted position of regulator(s) and tightened fitting.		
7. Backed-off regulator adjusting screw(s).		
8. Fully opened main cylinder valve(s).		
9. Adjusted inert (plasma) gas pressure.		
10. Adjusted inert (shielding) gas pressure.		
11. Attached inert gas hoses to regulator(s), welding machine, and torch as needed.		
12. Attached coolant adapter to coolant supply.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 5

SETTING UP PLASMA-ARC CUTTING/WELDING EQUIPMENT

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
13. Attached coolant hose to adapter.		
14. Checked for leaks.		
15. Inspected/positioned tungsten electrode.		
16. Installed inert gas cup.		
17. Connected ground lead to bench or workpiece and to power source terminal.		
18. Connected welding lead to power source terminal.		
19. Plugged in power source.		
20. Checked that hoses and leads were not kinked or obstructed.		
21. Checked that portable screens were in place.		
22. Secured cutting guide so that it was insulated from workpiece as needed.		
23. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

DUTY SETTING UP WELDING EQUIPMENT

PERFORMANCE OBJECTIVE 6

TASK

Set up SMAW (arc) welding equipment.

STANDARD OF PERFORMANCE OF TASK

The workpiece must be secured; the ground lead must provide continuity from the power source to the workpiece; the welding lead must provide continuity from the power source to the electrode holder, and both leads must be untangled; the power source must be plugged in; portable screens must be in place.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

AC and /or DC power source
Clamps
Electrode holder
Ground lead
Portable screens
Welding lead
Welder's standard tool kit

ENABLING OBJECTIVES

1. Know and demonstrate safe work practices.
2. Be familiar with basic welding terminology.
3. Identify SMAW (arc) welding equipment.

RESOURCES

1. Althouse et al. **Modern Welding**. Chapter 10.
2. Kennedy. **Welding Technology**. Chapter 13.
3. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 9.

TEACHING ACTIVITIES

1. Read and discuss any resources listed.
2. Have students identify the different types of shielded-metal arc welding machines.
3. Describe the safety precautions to observe in setting up shielded-metal arc welding equipment.
4. Identify shielded-metal arc welding equipment.
5. Demonstrate how to set up SMAW equipment.
6. Have students practice setting up SMAW equipment.

PERFORMANCE OBJECTIVE 6

CRITERION-REFERENCED MEASURE

Questions

1. Name three types of SMAW machines.
2. How are welding machines rated?
3. What does AC stand for?
4. What does DCRP stand for?
5. What does DCSP stand for?
6. What does duty cycle mean?
7. Welding cables are best if made from __________.

Answers

1. transformer, motor generator, rectifier
2. maximum amperage output
3. Alternating Current
4. Direct Current Reverse Polarity
5. Direct Current Straight Polarity
6. Duty cycle is the percentage of time during a ten-minute period that a machine can run continuously.
7. copper

Practical Application

Have students set up SMAW (arc) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 6 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 6

SETTING UP SMAW (ARC) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Secured workpiece to bench as needed.		
2. Attached ground lead to bench or workpiece and to power source.		
3. Attached welding lead to power source and electrode holder.		
4. Connected to power source.		
5. Checked that leads were not tangled or obstructed.		
6. Checked that portable screens were in place.		
7. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

DUTY SETTING UP WELDING EQUIPMENT

PERFORMANCE OBJECTIVE 7

TASK

Set up submerged-arc welding equipment.

STANDARD OF PERFORMANCE OF TASK

The workpiece must be secured in horizontal or flat position; the ground lead must provide continuity from the power source to the workpiece; the welding lead must provide continuity from the power source to the torch, and both leads must be untangled; the welding wire must be able to automatically feed through the torch when the mechanism is operated; the flux must be able to flow at the prescribed rate.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Clamps
Electrode wire
Flux
Semi-automated/automated submerged-arc welding equipment
Welder's standard tool kit

ENABLING OBJECTIVES

1. Demonstrate safe work practices.
2. Be familiar with basic welding terminology such as AC, DC, amperage, etc.

RESOURCE

Althouse et al. **Modern Welding**. pp. 459-461.

TEACHING ACTIVITIES

1. Read and discuss materials above.
2. Have students identify submerged-arc welding equipment.
3. Demonstrate how to set up submerged-arc welding equipment.
4. Have students identify fluxes to be used with submerged-arc welding equipment.
5. Have students practice setting up submerged-arc welding equipment.

PERFORMANCE OBJECTIVE 7

CRITERION-REFERENCED MEASURE

Questions

1. Submerged-arc welding is usually done on relatively thin metal. True or False?
2. One of the most outstanding advantages of submerged-arc welding is that it is very fast. True or False?
3. Submerged-arc welding is usually done under water. True or False?
4. What is used to pick up excess flux?

Answers

1. False
2. True
3. False
4. a vacuum

Practical Application

Have students set up submerged-arc welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 7 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 7

SETTING UP SUBMERGED-ARC WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**RATING**	
	Satisfactory	**Unsatisfactory**
1. Installed welding wire into wire-feed.		
2. Threaded welding wire through drive wheels of feeder.		
3. Filled hopper with flux.		
4. Made ground connection using wrench.		
5. Connected to power source.		
6. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY SETTING UP WELDING EQUIPMENT

PERFORMANCE OBJECTIVE 8

TASK

Set up GTAW (TIG) welding equipment.

STANDARD OF PERFORMANCE OF TASK

The inert gas cylinders must be secured, vented, and free from contamination or leaks; the regulators must provide the proper pressures and be free from leaks; the cooling system must provide sufficient cooling and be free from leaks; the leads must make contact; the inert gas hoses must be unobstructed; the workpiece and insulated guides must be secured in position; the portable screens must be in place.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

AC/DC power supply
Clamps
Collets
High frequency adapter
Hoses and fittings
Inert gas cylinder
Inert gas regulator
Inert gas cups
Portable screens
Power leads
Purge plates
Repair/Maintenance kit #2
TIG torch
Tungsten electrode
Water adapter
Water hose

ENABLING OBJECTIVES

1. Demonstrate safe work practices.
2. Select and use required basic tools.
3. Identify major components of GTAW (TIG) equipment.

RESOURCES

1. Althouse et al. **Modern Welding**. Chapters 11 and 12.
2. Kennedy. **Welding Technology**. Chapter 19.
3. Jeffus and Johnson. **Welding: Principles and Applications.** Chapter 14.

TEACHING ACTIVITIES

1. Have students read and discuss any resource listed.
2. Demonstrate how to set up TIG equipment.
3. Have students identify TIG equipment.
4. Have students identify the various types of gases used for TIG welding.
5. Have students practice setting up TIG equipment.
6. Have students identify the various types of tungsten electrodes and associated colors used for TIG welding.

PERFORMANCE OBJECTIVE 8

CRITERION-REFERENCED MEASURE

Questions

1. What is the difference between a water cooled rig and a dry rig?
2. What does TIG stand for?
3. What does GTAW stand for?
4. The collet holds the tungsten in place. True or False?
5. It is not necessary to use a high frequency when welding in AC. True or False?
6. Tungsten is a non-consumable material. True or False?
7. When welding 1/8 aluminum, what type of current is needed?
   a. DCRP
   b. DCSP
   c. AC
   d. ACHF
8. When welding 1/8 stainless steel what type of current is needed?
   a. DCRP
   b. DCSP
   c. AC
   d. ACHF

Answers

1. Water cooled rig is cooled by water; dry rig is cooled by air.
2. Tungsten Inert Gas
3. Gas Tungsten Arc Welding
4. True
5. False
6. True
7. d.
8. b.

Practical Application

Have students set up GTAW (TIG) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 8 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 8

SETTING UP GTAW (TIG) WELDING EQUIPMENT

Student's Name Date

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Insured that inert gas cylinder was secured in position.		
2. Removed protective cap.		
3. Opened and closed cylinder valve quickly to vent any foreign material.		
4. Attached regulator to cylinder valve.		
5. Adjusted position of regulator(s) and tightened using wrench.		
6. Connected gas hose to regulator and gas inlet on TIG machine and/or torch as needed.		
7. Backed off regulator adjusting screw.		
8. Fully opened gas cylinder valve.		
9. Adjusted gas pressure.		
10. Attached water adapter to water supply.		
11. Attached water hose to adapter and water inlet on TIG machine and/or torch as needed.		
12. Checked for leaks.		
13. Connected ground lead to bench or workpiece and to power source terminal.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 8

SETTING UP GTAW (TIG) WELDING EQUIPMENT

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
14. Inspected/positioned tungsten electrode in collet.		
15. Installed gas cup.		
16. Connected welding lead to power source.		
17. Connected to power source.		
18. Checked that hoses and leads were not kinked or obstructed.		
19. Purged gas to torch.		
20. Installed purge plate(s).		
21. Connected purge hoses.		
22. Checked for leaks.		
23. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

PERFORMING BURNING/WELDING ACTIVITIES

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 9

TASK

Burn (cut) material using hand-held torch.

STANDARD OF PERFORMANCE OF TASK

Drag lines must be vertical and not pronounced; cut must be sharp, clean, and within specified dimensions and angles.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Striker lighter
Metal cutting equipment
  (previously set up)
Protective clothing/equipment
Oxyacetylene cutting tips
Welder's standard tool kit
Work order
Workpiece showing cut lines

ENABLING OBJECTIVES

1. Read and interpret job specifications.
2. Demonstrate safe work practices.
3. Select and use basic tools.
4. Know how to set up dry fuel equipment.

RESOURCES

1. Althouse et al. **Modern Welding**. Chapter 6.
2. Kennedy. **Welding Technology**. Chapter 12.
3. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 8.

TEACHING ACTIVITIES

1. Have the students read and discuss any resources listed above.
2. Demonstrate how to cut a straight line.
3. Demonstrate how to cut a bevel.
4. Demonstrate how to cut a circle.
5. Demonstrate how to cut stacked plates.
6. Demonstrate how to cut pipe.
7. Demonstrate how to pierce a hole.
8. Demonstrate how to cut various patterns.
9. Have students practice cutting all of the above procedures.

PERFORMANCE OBJECTIVE 9

CRITERION-REFERENCED MEASURE

Questions

1. What is a neutral flame?

2. What is a carbonizing flame?

3. What is an oxidizing flame?

4. It is safe to use acetylene at 20 PSIG. True or Fale?

5. The kerf is the bottom side of the metal being cut. True or False?

6. The neutral flame is the best flame for cutting. True or False?

Answers

1. 50% oxygen, 50% acetylene
2. more acetylene than oxygen
3. more oxygen than acetylene
4. False
5. False
6. True

Practical Application

Have students burn (cut) material using hand-held torch.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 9 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 9

BURNING (CUTTING) MATERIAL USING HAND-HELD TORCH

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	**Unsatisfactory**
1. Consulted work order for specifications of cut.		
2. Put on protective attire.		
3. Checked that eye protection had required lenses for cutting procedure.		
4. Checked work area for hazards.		
5. Checked position of catch-box.		
6. Positioned/secured workpiece.		
7. Selected/installed cutting tip.		
8. Checked/cleaned tip as necessary.		
9. Adjusted gas pressures for cutting.		
10. Ignited torch.		
11. Adjusted pre-heating flame.		
12. Depressed cutting oxygen valve and readjusted flame as needed.		
13. Closed cutting oxygen valve.		
14. Positioned cutting torch at edge of workpiece.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 9

BURNING (CUTTING) MATERIAL USING HAND-HELD TORCH

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
15. Preheated metal to cutting temperature.		
16. Depressed cutting oxygen valve.		
17. Cut metal.		
18. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 10

TASK

Burn (cut) material using mechanized traveling/track torch equipment.

STANDARD OF PERFORMANCE OF TASK

Drag lines must be vertical and not pronounced; cut must be sharp and clean and within specified dimensions and angles.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Catch-box
Mechanized tractor
Metal cutting equipment
  (previously set up)
Oxyacetylene cutting tips
Protective clothing/equipment
Set of socket wrenches
Striker
Welder's standard tool kit
Work order
Workpiece showing cut lines

ENABLING OBJECTIVES

1. Demonstrate safe work practices.
2. Select and use basic tools.
3. Be able to lay out work to be cut.

RESOURCES

1. Althouse et al. **Modern Welding**. Chapter 6.
2. Kennedy. **Welding Technology**. Chapter 12.
3. Jeffus and Johnson. **Welding: Principles and Applications.** Chapter 8.

TEACHING ACTIVITIES

1. Have students read and discuss any resource listed.
2. Demonstrate how to set up track torch.
3. Demonstrate how to lay out and cut using the track torch.
4. Have students identify the parts of the track torch.
5. Have students lay out and practice cutting using the track torch.

PERFORMANCE OBJECTIVE 10

CRITERION-REFERENCED MEASURE

Questions

1. What two factors determine the travel speed?
2. A track torch can make a much higher quality cut than a hand-held torch. True or False?
3. Most track torches are driven by acetylene. True or False?
4. A track torch cuts basically the same metal that a hand-held torch cuts. True or False?

Answers

1. flame velocity and thickness of the metal
2. True
3. False
4. True

Practical Application

Have students burn (cut) material using mechanized torch equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 10 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 10

BURNING (CUTTING) MATERIAL USING MECHANIZED TRAVELING/TRACK TORCH EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for specifications of cut.		
2. Put on protective attire.		
3. Checked that eye protection had required lenses for cutting process.		
4. Checked work area for hazards.		
5. Checked position of catch-box.		
6. Positioned/secured workpiece.		
7. Selected /installed cutting tip.		
8. Checked/cleaned tip as necessary.		
9. Positioned torch in tractor saddle.		
10. Adjusted gas pressures for cutting.		
11. Ignited torch.		
12. Adjusted preheating flame.		
13. Opened cutting oxygen valve and readjusted flame as needed.		
14. Closed cutting oxygen valve.		
15. Positioned cutting head at edge of workpiece.		
16. Preheated metal.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 10

BURNING (CUTTING) MATERIAL USING MECHANIZED TRAVELING/TRACK TORCH EQUIPMENT

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
17. Opened cutting oxygen valve.		
18. Started/adjusted tractor travel.		
19. Adjusted flame and travel speed as necessary.		
20. Performed all work in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 11

TASK

Weld pipe using GMAW (MIG) welding equipment.

STANDARD OF PERFORMANCE OF TASK

Each pass must be deposited with complete fusion and must be free from sag and porosity; the bead must be smooth; the weld must be executed without undercutting, burn-through, or cracking; the underside of the root pass must make full (l/16" to l/8") penetration and be free of notches, icicles, or crevices; the final bead must overlap the groove size by l/8" inch.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

MIG welding equipment
  (previously set up)
Protective clothing
Wire brush/grinder
Work order
Workpiece
  (with joint prepared and tacked into position)

ENABLING OBJECTIVES

1. Knowledge of safety of MIG welding equipment.
2. Knowledge of setting up MIG welding equipment.
3. Choose the right type of shielding gas.

RESOURCE

Kennedy. **Welding Technology**. pp. 448-451.

TEACHING ACTIVITIES

1. Have students read and discuss resource listed.
2. Have students identify pipe positions.
3. Have students identify different types of MIG wire.
4. Have students identify different types of gas.
5. Demonstrate how to weld pipe with the MIG process.
6. Have students practice welding pipe with the MIG process.

PERFORMANCE OBJECTIVE 11

CRITERION-REFERENCED MEASURE

Questions

1. MIG welding of pipe is done in many positions. True or False?
2. Flux core MIG has been used when welding transmission pipe lines. True or False?
3. Sometimes MIG pipe welding is an automatic process. True or False?
4. There is no need to use a back-up ring when welding pipe. True or False?

Answers

1 True
2. True
3. True
4. False

Practical Application

Have students weld pipe using GMAW (MIG) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 11 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 11

WELDING PIPE USING GMAW (MIG) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**RATING**	
	Satisfactory	**Unsatisfactory**
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Ran test bead on piece of scrap metal.		
8. Readjusted gas flow rate, voltage, current, wire-feed speed, and inductance.		
9. Welded root pass.		
10. Wire brushed by hand and/or ground root pass smooth.		
11. Welded filler pass(es); wire brushed as necessary.		
12. Welded cover pass(es).		
13. Wire brushed by hand and/or ground smooth weldment as specified.		
14. Inspected weld.		
15. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 12

TASK

Weld pipe using oxyacetylene welding equipment.

STANDARD OF PERFORMANCE OF TASK

Each pass must be deposited with complete fusion and must be free from sag and porosity; the bead must be smooth; the weld must be executed without undercutting, burn-through, or cracking; the underside of the root pass must make full (1/16" to 1/8") penetration and be free of notches, icicles or crevices; the final bead must overlap the groove size by 1/8" inch.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Oxyacetylene welding equipment
  (previously set up)
Oxyacetylene welding tips
Protective attire
Welder's standard tool kit
Welding rods
Wire brush
Work order

ENABLING OBJECTIVES

1. Demonstrate safe work practices.
2. Select and use basic tools.
3. Know the dangers of oxygen and acetylene.

RESOURCES

1. Althouse et al. **Modern Welding**. pp. 528-529.
2. Kennedy. **Welding Technology**. Chapter 10.
3. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 6.

TEACHING ACTIVITIES

1. Have the students read and discuss any resources listed.
2. Have students identify pipe welding positions.
3. Demonstrate how to fit and tack pipe.
4. Demonstrate how to weld pipe in all positions.
5. Have students practice welding pipe in all positions.

PERFORMANCE OBJECTIVE 12

CRITERION-REFERENCED MEASURE

Questions

1. The filler metal must always _______ the base metal.
2. The reason for beveling pipe is to allow more _______.
3. When welding is done in a 6G position, the pipe is in a (an) _______ angle.
4. Before welding, the pipe should be tacked in _______ places.
5. A keyhole can be used to insure _______ penetration.

Answers

1. match
2. penetration
3. 45 degree
4. 4
5. 100%

Practical Application

Have students weld pipe using oxyacetylene welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 12 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 12

WELDING PIPE USING OXYACETYLENE WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Checked work area for hazards.		
3. Selected/installed welding tip.		
4. Checked/cleaned tip as necessary.		
5. Selected welding rod.		
6. Adjusted gas pressures for welding.		
7. Put on protective attire.		
8. Rechecked positioning of workpiece.		
9. Ignited torch.		
10. Adjusted flame.		
11. Readjusted regulators as needed.		
12. Welded pipe.		
13. Cleaned weld as needed.		
14. Inspected weld.		
15. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 13

TASK

Weld pipe using SMAW (arc) welding equipment.

STANDARD OF PERFORMANCE OF TASK

Each pass must be deposited with complete fusion and must be free from slag inclusions, sag, and porosity; the bead must be smooth; the weld must be executed without undercutting, burn-through, or cracking; the underside of the root pass must make full (1/16" to 1/8") penetration and be free of notches, icicles, or crevices; the final bead must overlap the groove size by 1/8".

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Grinder
Welder's standard tool kit
Protective clothing/equipment
SMAW welding equipment
  (previously set up)
Portable screens
Wire brush
Work order
Workpiece
  (with joint prepared
  and tacked into
  position)

ENABLING OBJECTIVES

1. Demonstrate safe work practices.
2. Select and use basic tools.
3. Know how to set up SMAW equipment.

RESOURCES

1. Kennedy. **Welding Technology**. Chapter 23.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 13.

TEACHING ACTIVITIES

1. Have the students read and discuss any resources listed.
2. Have students identify pipe welding positions.
3. Demonstrate how to fit and tack pipe.
4. Demonstrate how to weld pipe in all positions.
5. Have students practice welding pipe in all positions.

PERFORMANCE OBJECTIVE 13

CRITERION-REFERENCED MEASURE

Questions

1. When welding, all passes are important, but the _______ pass is the most important.
2. To insure good penetration, _______ the pipe before welding.
3. To insure good penetration at the root, use a (an) _________ or _______ electrode for the root pass.
4. Tacks should be made at _______, _______, _______, and _______.

Answers

1. root
2. bevel
3. E6010 or E7010
4. 3 o'clock, 6 o'clock, 9 o'clock, 12 o'clock

Practical Application

Have students weld pipe using SMAW (arc) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 13 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 13

WELDING PIPE USING SMAW (ARC) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked that hood had required lens for welding.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Ran test bead on piece of scrap metal.		
8. Readjusted voltage, current, and inductance as required.		
9. Welded root pass.		
10. Chipped slag.		
11. Wire brushed by hand and/or ground root pass smooth.		
12. Welded filler pass(es), chipped slag, and wire brushed as required.		
13. Welded over passes.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 13

WELDING PIPE USING SMAW (ARC) WELDING EQUIPMENT

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
14. Chipped slag.		
15. Wire brushed and/or ground smooth weldment as specified.		
16. Inspected weld.		
17. Performed all work in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 14

TASK

Weld pipe using submerged-arc welding equipment.

STANDARD OF PERFORMANCE OF TASK

Each pass must be deposited with complete fusion and must be free from sag and porosity; the bead must be smooth; the weld must be executed without undercutting, burn-through, or cracking; the underside of the root pass must make full (1/16" to 1/8") penetration and be free of notches, icicles, or crevices; the final bead must overlap the groove size by 1/8".

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Electrode wire
Flux
Welder's standard tool kit
Workpiece
  (with joint prepared and tacked
  into position)
Semi-automated/automated
  submerged-arc welding equipment
  (previously set up)
Protective clothing
Wire brush
Work order

ENABLING OBJECTIVES

1. Demonstrate safe work practices.
2. Be familiar with basic welding terminology

RESOURCE

Jeffus and Johnson. **Welding: Principles and Practices**. pp. 870-72.

TEACHING ACTIVITIES

1. Have the students read and discuss resource.
2. Have students identify submerged-arc pipe equipment.
3. Demonstrate how to fit and tack pipe.
4. Demonstrate how to submerged-arc weld pipe.
5. Have students practice welding pipe.

PERFORMANCE OBJECTIVE 14

CRITERION-REFERENCED MEASURE

Questions

1. The arc is not buried under the flux. True or False?
2. Most of the time submerged-arc welding of pipe requires a weld turntable. True or False?
3. Submerged-arc welding of pipe may be automatic or semi-automatic. True or False?
4. The electrode used may be many different sizes. True or False?

Answers

1. False
2. True
3. True
4. True

Practical Application

Have students weld pipe using submerged-arc welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 14 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 14

WELDING PIPE USING SUBMERGED-ARC WELDING EQUIPMENT

Student's Name Date

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Readjusted voltage, current, wire-feed rate, and flux-feed rate.		
8. Welded root pass.		
9. Wire brushed by hand and/or ground root pass smooth, recycling unfused flux.		
10. Welded filler pass(es), wire brushed, and recycled unfused flux.		
11. Welded cover pass(es).		
12. Recycled unfused flux.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 14

WELDING PIPE USING SUBMERGED-ARC WELDING EQUIPMENT

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
13. Wire brushed by hand and/or ground smooth weldment as specified in work order.		
14. Inspected weld.		
15. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature Date

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 15

TASK

Weld pipe using tungsten inert gas (TIG) welding equipment.

STANDARD OF PERFORMANCE OF TASK

Each pass must be deposited with complete fusion and must be free from sag and porosity; the bead must be smooth; weld must be executed without undercutting, burn-through, or cracking; tacks must be consumed; the underside of the root pass must make full (1/16" to 1/8") penetration and be free of notches, "suck-back," icicles, or crevices; the final bead must overlap the groove size by 1/8".

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Grinder
Protective clothing/equipment
Repair/Maintenance kit #2
TIG welding equipment
(previously set up)
Workpiece
(with joint prepared and
tacked into position)
Wire brush
Work order

ENABLING OBJECTIVES

1. Demonstrate safe work practices.
2. Select and use basic tools.
3. Know how to set up GTAW equipment.

RESOURCE

Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 16.

TEACHING ACTIVITIES

1. Have students read and discuss resource listed.
2. Have students identify pipe welding positions.
3. Demonstrate how to fit and tack pipe.
4. Demonstrate how to TIG weld pipe in all positions.
5. Have students practice welding pipe in all positions.

PERFORMANCE OBJECTIVE 15

CRITERION-REFERENCED MEASURE

Questions

1. The 1G position indicates the pipe is ________.
2. TIG welding can be done on stainless steel pipe. True or False?
3. TIG welding always needs some type of shielding gas. True or False?
4. The TIG welding process is used on pipe because of the ________.

Answers

1. horizontally rolled
2. True
3. True
4. ease of puddle control

Practical Application

Have students weld pipe using tungsten inert gas (TIG) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 15 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 15

WELDING PIPE USING TUNGSTEN INERT GAS (TIG) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked that eye protection equipment had required lens for welding process.		
4. Checked work area for hazards, especially toxic gases.		
5. Rechecked positioning of workpiece.		
6. Feathered tacks.		
7. Turned on welding machine.		
8. Readjusted gas flow rate, voltage, current, and water flow.		
9. Welded root pass.		
10. Wire brushed/ground root pass smooth.		
11. Welded filler pass(es); wire brushed as specified.		
12. Welded cover pass(es).		
13. Wire brushed by hand and/or ground smooth weldment as specified.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 15

WELDING PIPE USING TUNGSTEN INERT GAS (TIG) WELDING EQUIPMENT

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
14. Inspected weld.		
15. Performed all work in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 16

TASK

Make fillet weld using GMAW (MIG) welding equipment.

STANDARD OF PERFORMANCE OF TASK

The weld must be deposited with complete fusion and must be free from overlapping, cracking, and porosity; it must be at least 25% greater in width than depth without undercutting; it must possess the specified convexity/concavity.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Grinder
MIG welding equipment
 (previously set up)
Protective clothing
Weld gauge (fillet)
Wire brush
Work order
Workpiece
 (with joint prepared and
 tacked into position)

ENABLING OBJECTIVES

1. Match GMAW machine controls with their functions.
2. Match GMAW electrical controls with their functions.
3. Select and use basic tools.
4. Demonstrate safe work practices.

RESOURCES

1. Mid-America Vocational Curriculum Consortium, Inc. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 18, pp. 364-389.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Show students how to complete the equipment check set up for spray-arc transfer.
3. Demonstrate how to make a test bead on scrap metal and how to make required adjustments.
4. Demonstrate how to position the gun at the correct angle to the joint and how to check the ESO (electric stick out).

TEACHING ACTIVITIES (Continued)

5. Show students the correct technique to weld the joint.
6. Discuss how to clean and inspect the joint properly.
7. Have the students complete the performance steps of the task.

CRITERION-REFERENCED MEASURE

Questions

1. Changing the wire feed speed changes which of the following?
    a. arc potential
    b. voltage
    c. amperage
    d. there is no change

2. Changing the gun angle from a leading angle to a trailing angle changes the
    a. amount of gas flow required.
    b. welding current.
    c. voltage.
    d. weld bead width and penetration.

3. Increasing the electrode stick out (ESO) will cause
    a. penetration to decrease.
    b. penetration to increase.
    c. the width of the bead to increase.
    d. the height of the bead to decrease.

Answers

1. c.
2. d.
3. a.

Practical Application

Have students make fillet weld using GMAW (MIG) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 16 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 16

MAKING FILLET WELD USING GMAW (MIG) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Ran test bead on piece of scrap metal.		
8. Readjusted inert gas flow rate, voltage, current, wire-feed speed, and inductance.		
9. Ran fillet weld.		
10. Wire brushed by hand and/or ground as specified.		
11. Inspected weld.		
12. Measured weld.		
13. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 17

TASK

Make fillet weld using oxyacetylene welding equipment.

STANDARD OF PERFORMANCE OF TASK

The weld must be deposited with complete fusion and must be free from slag, overlapping, cracking, and porosity; it must be at least 25% greater in width than depth without undercutting; it must possess the specified convexity/concavity.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Oxyacetylene welding equipment (previously set up)
Oxyacetylene welding tips
Protective clothing
Weld gauge (fillet)
Flint striker
Welding rods
Wire brush
Work order
Workpiece (with joint prepared and tacked into position)

ENABLING OBJECTIVES

1. Make the proper tip selection for the thickness of the metal to be welded.
2. Use the correct method of attaching the tip to the torch body.
3. Know the correct regulator pressures required to match tip size and metal thickness.
4. Use the correct method of lighting and adjusting the torch to a neutral flame.

RESOURCES

1. Mid-America Vocational Curriculum Consortium, Inc. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 5, pp. 77-101.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Show the students how to complete the equipment check set up for oxyacetylene welding a fillet weld.
3. Demonstrate how to correctly position torch and filler rod.

PERFORMANCE OBJECTIVE 17

TEACHING ACTIVITIES (Continued)

4. Show students the proper torch movement and how to dip the filler rod.
5. Demonstrate how to stop before reaching the end of the joint.
6. Discuss how to clean and inspect the joint properly.
7. Have students complete the performance steps of the task in a safe manner.

CRITERION-REFERENCED MEASURE

Questions

1. When selecting a welding tip the welder should be concerned with the
   a. number of the tip.
   b. size of the tip.
   c. diameter of the hole.
   d. angle of bend in the tip.

2. A flame which heats the metal and does not add carbon or oxygen to it is known as a(n)
   a. oxidizing flame.
   b. carburizing flame.
   c. carburizing and oxidizing flame.
   d. neutral flame.

3. To prevent overheating at the end of the joint
   a. add more filler metal.
   b. travel faster.
   c. flash the torch off the weld.
   d. readjust the flame.

Answers

1. a.
2. d.
3. c.

Practical Application

Have students make fillet weld using oxyacetylene welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 17 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 17

MAKING FILLET WELDS USING OXYACETYLENE WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Checked work area for hazards.		
3. Selected /installed welding tip.		
4. Checked/cleaned tip as necessary.		
5. Selected welding rod.		
6. Adjusted oxygen and acetylene pressures for welding.		
7. Put on protective attire.		
8. Rechecked positioning of workpiece.		
9. Ignited torch.		
10. Adjusted flame.		
11. Readjusted regulators as needed.		
12. Ran fillet weld.		
13. Brushed weld as specified.		
14. Inspected weld.		
15. Measured weld.		
16. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 18

TASK

Make fillet weld using SMAW (arc) welding equipment.

STANDARD OF PERFORMANCE OF TASK

The weld must be deposited with complete fusion and must be free from slag, overlapping, cracking, and porosity; it must be at least 25% greater in width than depth without undercutting; it must possess the specified convexity/concavity.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Chipping hammer
Electrodes
Grinder
SMAW welding equipment
(previously set up)
Portable screens
Protective clothing
Weld gauge (fillet)
Wire brush
Work order
Workpiece
(with joint prepared and tacked into position)

ENABLING OBJECTIVES

1. Match terms related to SMAW equipment, application, and techniques with their correct definitions.
2. Identify equipment needed to make a fillet weld using SMAW (arc) welding equipment.
3. Match types of electrodes used to make fillet welds.
4. Select and use basic arc welding cleaning tools.
5. Demonstrate safe work practices required in arc welding.

RESOURCES

1. Mid-America Vocational Curriculum Consortium, Inc. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 11, pp. 201-225.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Show students how to correctly match polarity for electrodes to be used.

TEACHING ACTIVITIES (Continued)

3. Demonstrate how to adjust to correct amperage by running short beads on scrap material.
4. Show students the electrode angle, arc length, and travel speed to make correct bead shape.
5. Discuss the proper method of cleaning slag from the weld.
6. Have students complete the performance steps of the task in a safe manner.

CRITERION-REFERENCED MEASURE

Questions

1. How can an arc be started accurately?
   a. bouncing it quickly against the plate
   b. resting the electrode against free hand
   c. lowering helmet just after the arc starts
   d. arc starting is never accurate

2. The rate at which weld metal is added to the weld is known as the
   a. deposition rate.
   b. travel rate.
   c. electrode burn rate.
   d. rate of build up.

3. If the slag is not removed from the tack weld
   a. the slag will not melt during welding.
   b. the heat from the approaching weld will cause the slag to break free.
   c. the slag will cause a slag inclusion.
   d. the slag will not hold the parts together for welding.

Answers

1. b.
2. a.
3. c.

Practical Application

Have students make fillet weld using SMAW (arc) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 18 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 18

MAKING FILLET WELDS USING SMAW (ARC) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	**Unsatisfactory**
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked that hood had required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Ran test bead on piece of scrap metal.		
8. Readjusted voltage, current, and inductance as required.		
9. Ran fillet weld.		
10. Chipped slag.		
11. Wire brushed and/or ground as specified.		
12. Inspected weld.		
13. Measured weld.		
14. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 19

TASK

Make fillet weld using submerged-arc welding equipment.

STANDARD OF PERFORMANCE OF TASK

The weld must be deposited with complete fusion and must be free from overlapping, cracking, and porosity; it must be at least 25% greater in width than depth without undercutting; it must possess the specified convexity/concavity.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Electrode wire
Flux
Protective clothing
Semi-automated/automated submerged-arc welding equipment (previously set up)
Weld gauge (fillet)
Wire brush
Work order
Workpiece (with joint prepared and tacked into position)

ENABLING OBJECTIVES

1. Match submerged-arc welding (SAW) machine controls with their functions.
2. Match submerged-arc welding (SAW) electrical controls with their functions.
3. Match filler wire and fluxes for making a fillet weld using submerged-arc welding equipment.
4. Identify basic submerged-arc welding (SAW) techniques.
5. Demonstrate safe work practices required in submerged-arc welding.

RESOURCE

Smith. **Welding Skills and Technology**. pp. 462-493.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Demonstrate how to set submerged-arc welding machine controls to make a fillet weld.
3. Demonstrate correct wire feed and flux feed to make a fillet weld.
4. Have the students complete the performance steps of the task in a safe manner.

PERFORMANCE OBJECTIVE 19

CRITERION-REFERENCED MEASURE

Questions

1. During submerged-arc welding the filler wire
   a. does not touch the work.
   b. lightly touches the work.
   c. is above the flux.
   d. is partially covered by flux.

2. Submerged-arc welding is usually done in
   a. flat position.
   b. horizontal position.
   c. vertical position.
   d. overhead position.

3. Submerged-arc welding takes place beneath a blanket of granular, fusible flux which
   a. partially hides the arc.
   b. completely hides the arc.
   c. does not hide the arc.
   d. none of the above

Answers

1. b.
2. a.
3. b.

Practical Application

Have students make fillet weld using submerged-arc welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 19 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 19

MAKING FILLET WELDS USING SUBMERGED-ARC WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT — Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR — Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Ran test bead.		
8. Readjusted voltage, current, wire-feed rate, and flux-feed rate.		
9. Ran fillet weld.		
10. Wire brushed/ground weld as specified.		
11. Recycled unfused flux.		
12. Inspected weld.		
13. Measured weld.		
14. Performed all tasks in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 20

TASK

Make fillet weld using tungsten inert gas (TIG) welding equipment.

STANDARD OF PERFORMANCE OF TASK

The weld must be deposited with complete fusion and must be free from overlapping, cracking, and porosity; it must be at least 25% greater in width than depth without undercutting; it must possess the specified convexity/concavity.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Grinder
TIG welding equipment
Protective clothing
Filler metal
Weld gauge (fillet)
Wire brush
Work order
Workpiece (with joint prepared and tacked into position)

ENABLING OBJECTIVES

1. Match terms related to TIG equipment, application, and techniques with their correct definitions.
2. Match TIG machine controls with their functions.
3. Identify basic parts of a TIG torch.
4. Match types of cups with their functions.
5. Demonstrate safe work practices required in TIG welding.

RESOURCES

1. Mid-America Vocational Curriculum Consortium, Inc. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 15, pp. 293-320.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Show the students how to correctly match polarity and the type of metal to be TIG welded.
3. Show the students the correct torch angle, arc length, and travel speed required to make a fillet weld in TIG welding.
4. Demonstrate how the filler rod is added to the fillet weld in TIG welding.
5. Have the students complete the performance steps of the task in a safe manner.

PERFORMANCE OBJECTIVE 20

CRITERION-REFERENCED MEASURE

Questions

1. The gas must continue flowing for a short time after a weld is stopped temporarily
   a. to keep the weld crater from oxidizing.
   b. to prevent the tungsten from oxidizing.
   c. to prevent oxides from forming on the filler metal.
   d. all of the above

2. If the torch angle is excessive,
   a. weld heat will not penetrate the plate.
   b. ultraviolet light is more likely to burn the welder.
   c. air can be pulled into the weld zone.
   d. all of the above

3. The filler rod should enter the welding zone as close as possible to the base metal
   a. because it is much easier to move the rod.
   b. to prevent the arc from accidentally striking the rod.
   c. so that the welder's visibility is not blocked.
   d. to prevent air from being pulled into the weld shielding gas.

Answers

1. d.
2. c.
3. d.

Practical Application

Have students make fillet weld using tungsten inert gas (TIG) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 20 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 20

MAKING FILLET WELDS USING TUNGSTEN INERT GAS (TIG) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT	Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Ran test bead.		
8. Readjusted gas flow rate, voltage, current, and water flow.		
9. Ran fillet weld.		
10. Wire brushed by hand and/or ground as specified.		
11. Visually inspected weld.		
12. Measured weld.		
13. Performed all tasks in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 21

TASK

Make full penetration weld using GMAW (MIG) welding equipment.

STANDARD OF PERFORMANCE OF TASK

Each pass must be deposited with complete fusion and must be free from cracking and porosity; the root pass must provide full penetration without burning away the root faces.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Filler metal
Grinder
MIG welding equipment (previously set up)
Protective clothing
Wire brush
Work order
Workpiece (with joint prepared)
Workpiece (with joint prepared and tacked into position)

ENABLING OBJECTIVES

1. Match GMAW (MIG) machine controls with their functions.
2. Match GMAW (MIG) electrical controls with their functions.
3. Match wire feeder controls with their functions.
4. Identify basic GMAW (MIG) techniques.
5. Demonstrate safe work practices required in GMAW (MIG) welding.

RESOURCES

1. Mid-America Vocational Curriculum Consortium, Inc. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 18, pp. 364-389.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Demonstrate how to set machine controls and electrical controls to make a full penetration weld.
3. Demonstrate correct gun angle to joint and check ESO (electrode stick-out).
4. Have students complete the performance steps of the task in a safe manner.

PERFORMANCE OBJECTIVE 21

CRITERION-REFERENCED MEASURE

Questions

1. Misalignment of the feeder roller and the conduit may cause
   a. slow wire feed.
   b. bird nesting.
   c. irregular voltage.
   d. shorting.

2. Changing the wire feed speed changes which of the following?
   a. arc potential
   b. voltage
   c. amperage
   d. there is no change

3. Changing the gun angle from a leading angle to a trailing angle changes the
   a. amount of gas flow required.
   b. welding current.
   c. voltage.
   d. weld bead width and penetration.

Answers

1. b.
2. c.
3. d.

Practical Application

Have students make full penetration weld using GMAW (MIG) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 21 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 21

MAKING FULL PENETRATION WELD USING GMAW (MIG) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	**Unsatisfactory**
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Ran test bead on piece of scrap metal.		
8. Readjusted gas flow rate, voltage, current, wire-feed speed, and inductance.		
9. Ran root pass.		
10. Wire brushed/ground root pass as specified.		
11. Ran filler pass(es); wire brushed as necessary.		
12. Wire brushed by hand and/or ground smooth weldment as specified.		
13. Visually inspected weld.		
14. Performed all tasks in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 22

TASK

Make full penetration weld using oxyacetylene welding equipment.

STANDARD OF PERFORMANCE OF TASK

Each pass must be deposited with complete fusion and must be free from slag, cracking, and porosity; the root pass must provide full penetration without burning away the root faces.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Oxyacetylene welding equipment (previously set up)
Oxyacetylene welding tips
Protective attire
Welding rods
Wire brush/grinder
Work order
Workpiece (with joint prepared and tacked into position)

ENABLING OBJECTIVES

1. Make the proper tip selection for the thickness of the metal to be welded.
2. Use the correct method of attaching the tip to the torch body.
3. Set the correct regulator pressures required to match tip size and metal thickness.
4. Identify the correct method of lighting and adjusting the torch to a neutral flame.
5. Demonstrate safe work practices.

RESOURCES

1. Mid-America Vocational Curriculum Consortium, Inc. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 5, pp. 77-101.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Show students how to complete the equipment check set up for oxyacetylene welding a full penetration weld using oxyacetylene equipment.

TEACHING ACTIVITIES (Continued)

3. Demonstrate tacking procedures and the proper method of preparing edges of the joint.
4. Show students the proper torch angle, movement of torch, and how to dip the filler rod when making a full penetration weld.
5. Discuss how to properly clean and inspect the weld.
6. Have students complete the performance steps of the task in a safe manner.

CRITERION-REFERENCED MEASURE

Questions

1. The ideal torch angle is
   a. 25 degrees.
   b. 35 degrees.
   c. 45 degrees.
   d. 55 degrees.

2. When the parent metal at the edge of the puddle melts down creating a circular hole, it is called
   a. a crater.
   b. undercutting.
   c. a keyhole.
   d. hot shortness.

3. If the end of the filler rod is not kept inside the flame the weld will be
   a. more ductile.
   b. stronger.
   c. softer.
   d. brittle.

Answers

1. c.
2. c.
3. d.

Practical Application

Have students make full penetration weld using oxyacetylene welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 22 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 22

MAKING FULL PENETRATION WELDS USING OXYACETYLENE WELDING EQUIPMENT

Student's Name Date

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Checked work area for hazards.		
3. Selected/installed welding tip.		
4. Checked/cleaned tip as necessary.		
5. Selected welding rod.		
6. Adjusted gas pressures for welding.		
7. Put on protective attire.		
8. Rechecked positioning of workpiece.		
9. Ignited torch.		
10. Adjusted flame.		
11. Readjusted regulators as needed.		
12. Ran root pass.		
13. Wire brushed by hand and/or ground root pass as specified.		
14. Ran filler passes.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 22

MAKING FULL PENETRATION WELDS USING OXYACETYLENE WELDING EQUIPMENT

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
15. Wire brushed by hand and/or ground weld as specified.		
16. Visually inspected weld.		
17. Performed all work in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature Date

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 23

TASK

Make full penetration weld using plasma-arc welding equipment.

STANDARD OF PERFORMANCE OF TASK

Each pass must provide full penetration without burning away the root edges, and it must be deposited with complete fusion, free from cracking and porosity.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Clamps
Filler rod
Grinder
Plasma-arc welding equipment (previously set up)
Portable screens
Protective clothing/equipment
Wire brush
Work order
Workpiece (with joint prepared and tacked into position)

ENABLING OBJECTIVES

1. Match plasma-arc machine controls with their functions.
2. Match plasma-arc electrical controls with their functions.
3. Identify basic plasma-arc techniques.
4. Demonstrate safe work practices required in plasma-arc welding.

RESOURCES

1. Mid-America Vocational Curriculum Consortium. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 20, pp. 426-28.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Demonstrate how to set machine controls.
3. Demonstrate how to set electrical controls.
4. Demonstrate correct torch angle for making a full penetration weld using plasma-arc welding equipment.
5. Have students complete the performance steps of the task in a safe manner.

PERFORMANCE OBJECTIVE 23

CRITERION-REFERENCED MEASURE

Questions

1. An outstanding advantage of plasma is
   a. it is quiet.
   b. the high temperature and better heat transfer to other objects.
   c. it is less expensive.
   d. the high cost.

2. The plasma arc produces temperatures in excess of
   a. 3,000 degrees F.
   b. 5,000 degrees F.
   c. 6,800 degrees F.
   d. 10,000 degrees F.

3. The high temperature that is provided by a plasma torch is produced by which of the following?
   a. a plasma changing back into a gas
   b. the arc between the work and torch through an inert gas
   c. the constant attack of an ionized gas by positively charged electrons
   d. the focusing of a highly intense arc into a small space

Answers

1. b.
2. d.
3. c.

Practical Application

Have students make full penetration weld using plasma-arc welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 23 to detemine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 23

MAKING FULL PENETRATION WELDS USING PLASMA-ARC WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT: Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Readjusted gas flow rate, voltage, current, and water flow.		
8. Ran weld.		
9. Wire brushed/ground weldment as specified.		
10. Visually inspected weld.		
11. Performed all tasks in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 24

TASK

Make full penetration weld using SMAW (arc) welding equipment.

STANDARD OF PERFORMANCE OF TASK

Each pass must be deposited with complete fusion and must be free from slag, cracking, and porosity; the root pass must provide full penetration without burning away the root edges.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Chipping hammer
Electrodes
Grinder
SMAW welding equipment
  (previously set up)
Protective clothing/equipment
Workpiece
  (with joint prepared and
  tacked into position)
Wire brush
Work order
Portable screens

ENABLING OBJECTIVES

1. Match terms related to SMAW equipment, applications, and techniques with their correct definitions.
2. Identify equipment needed to make a full penetration weld using SMAW (arc) welding equipment.
3. Match types of electrodes used to make full penetration welds.
4. Select and use arc welding cleaning tools.
5. Demonstrate safe work practices required in arc welding.

RESOURCES

1. Mid-America Vocational Curriculum Consortium, Inc. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 11, pp. 201-225.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Show students how to correctly match polarity for electrodes used in making full penetration welds in arc welding.

TEACHING ACTIVITIES (Continued)

3. Demonstrate how to make the correct bevel and correct spacing of plates for full penetration welds.
4. Demonstrate the correct electrode angle, correct arc length, and travel speed to make correct bead shape.
5. Discuss the correct method of cleaning slag from each bead as it is welded.
6. Have the students complete the performance steps of the task in a safe manner.

CRITERION-REFERENCED MEASURE

Questions

1. Edge preparation
    a. makes joint alignment easier.
    b. minimizes distortion.
    c. allows deeper penetration.
    d. all of the above

2. The root pass is used to
    a. hold the parts in proper alignment.
    b. seal off possible atmospheric contamination.
    c. help control distortion.
    d. all of the above

3. The hot pass is used to
    a. improve the root bead contour.
    b. burn out trapped slag.
    c. add filler metal to the joint.
    d. all of the above

Answers

1. c.
2. b.
3. d.

Practical Application

Have students make full penetration weld using SMAW (arc) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 24 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 24

MAKING FULL PENETRATION WELDS USING SMAW (ARC) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked that hood had required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Ran test bead on piece of scrap metal.		
8. Readjusted voltage, current, and inductance as required.		
9. Ran root pass.		
10. Chipped slag.		
11. Wire brushed by hand and/or ground root pass as specified.		
12. Ran filler pass(es), chipped slag, and wire brushed as required.		
13. Ran cover pass(es).		

CHECKLIST FOR PERFORMANCE OBJECTIVE 24

MAKING FULL PENETRATION WELDS USING SMAW (ARC) WELDING EQUIPMENT

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
14. Chipped slag.		
15. Wire brushed by hand and/or ground weldment as specified.		
16. Visually inspected weld.		
17. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature Date

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 25

TASK

Make full penetration weld using submerged-arc welding equipment.

STANDARD OF PERFORMANCE OF TASK

Each pass must be deposited with complete fusion and must be free from cracking and porosity; the root pass must provide full penetration without burning away the root edges.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Electrode wire
Flux
Grinder
Protective clothing/equipment
Semi-automated/automated submerged-arc welding equipment (previously set up)
Wire brush
Work order
Workpiece (with joint prepared and tacked into position)

ENABLING OBJECTIVES

1. Match submerged-arc welding (SAW) machine controls with their functions.
2. Match submerged-arc welding (SAW) electrical controls with their functions.
3. Match filler wire and fluxes that make a full penetration weld using the submerged-arc process.
4. Identify basic submerged-arc welding (SAW) techniques.
5. Demonstrate safe work practices required in submerged-arc welding.

RESOURCE

Smith. **Welding Skills and Technology**. pp. 462-493.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Demonstrate how to set submerged-arc welding machine controls to make a full penetration weld.

PERFORMANCE OBJECTIVE 25

TEACHING ACTIVITIES (Continued)

3. Demonstrate correct wire feed and flux feed to make a full penetration weld with the submerged-arc process.
4. Have the students complete the performance steps of the task in a safe manner.

CRITERION-REFERENCED MEASURE

Questions

1. The power source for submerged-arc welding machines can be
   a. only AC machines.
   b. only DC machines.
   c. either AC or DC machines.
   d. none of the above.

2. The purpose of the flux during submerged-arc welding is to
   a. protect the molten metal from oxidation.
   b. protect the operator from arc flashes.
   c. keep the hopper clean.
   d. reduce the arc glare.

3. The submerged arc welding process is best when welding
   a. light gauge metal.
   b. thick metal plates.
   c. different types of metal.
   d. hard to reach joints.

Answers

1. c.
2. a.
3. b.

Practical Application

Have students make full penetration weld using submerged-arc welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 25 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 25

MAKING FULL PENETRATION WELDS USING SUBMERGED-ARC WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Readjusted voltage, current, wire-feed rate, and flux-feed rate.		
8. Ran root pass.		
9. Wire brushed by hand and/or ground root pass smooth, recycling unfused flux.		
10. Ran filler pass(es), wire brushed, and recycled unfused flux.		
11. Wire brushed by hand and/or ground smooth weldment as specified in work order.		
12. Visually inspected weld.		
13. Performed all tasks in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 26

TASK

Make full penetration weld using tungsten inert gas (TIG) welding equipment.

STANDARD OF PERFORMANCE OF TASK

Each pass must be deposited with complete fusion and must be free from cracking and porosity; tacks must be fully consumed; the root pass must provide full penetration without burning away the root edges.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Grinder
Purge plates
Protective clothing
Repair/Maintenance kit #2
Work brush
Work order
Workpiece (with joint prepared and tacked into position)

ENABLING OBJECTIVES

1. Match terms related to TIG equipment, applications, and techniques with their correct definitions.
2. Match TIG machine controls with their functions.
3. Identify basic parts of the TIG torch.
4. Match types of cups with their functions.
5. Demonstrate safe work practices required in TIG welding.

RESOURCES

1. Mid-America Vocational Curriculum Consortium, Inc. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 15, pp. 293-320.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Show the students how to correctly match polarity and the type of metal to be TIG welded.
3. Demonstrate how to prepare the edges of the plates for a full penetration weld in TIG welding.

TEACHING ACTIVITIES (Continued)

4. Show the students the correct torch angle, correct arc length, and travel speed required to make a full penetration TIG weld.
5. Demonstrate how the filler rod is added to a full penetration TIG weld.
6. Have the students complete the performance steps of the task in a safe manner.

CRITERION-REFERENCED MEASURE

Questions

1. On most jobs tungsten contamination in the weld must be
   a. wire brushed.
   b. remelted.
   c. allowed to cool before rewelding.
   d. removed.

2. The proper shielding gas flow rate is determined by the
   a. welding current and cup size.
   b. welding speed and filler metal size.
   c. welding position and operator skill.
   d. metal type and hose length.

3. To insure adequate root fusion on full penetration welds, it may be necessary to
   a. add more filler rod.
   b. keep the arc on one side of the joint.
   c. move the torch in and around the base of the puddle.
   d. add very little filler metal.

Answers

1. d.
2. a.
3. c.

Practical Application

Have students make full penetration weld using tungsten inert gas (TIG) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 26 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 26

MAKING FULL PENETRATION WELDS USING TUNGSTEN INERT GAS (TIG) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT — Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR — Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Installed purge plates.		
7. Turned on welding machine.		
8. Readjusted inert gas flow rate, voltage, current, and water flow.		
9. Ran root pass.		
10. Wire brushed by hand and/or ground root pass as specified.		
11. Ran filler pass(es); wire brushed as specified.		
12. Wire brushed by hand and/or ground weldment as specified.		
13. Visually inspected weld.		
14. Performed all tasks in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 27

TASK

Make plug weld using GMAW (MIG) welding equipment.

STANDARD OF PERFORMANCE OF TASK

The weld must be deposited with complete fusion in both members without overlapping, cracking, porosity, or overpenetration.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Filler metal
Grinder
MIG welding equipment
(previously set up)
Wire brush
Work order
Workpiece
Protective clothing/equipment

ENABLING OBJECTIVES

1. Match GMAW (MIG) machine controls with their functions.
2. Match GMAW (MIG) electrical controls with their functions.
3. Match wire feeder controls with their functions.
4. Identify basic GMAW (MIG) techniques.
5. Demonstrate safe work practices required in GMAW (MIG) welding.

RESOURCES

1. Mid-America Curriculum Consortium, Inc. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 18, pp. 364-389.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Demonstrate how to set machine controls and electrical controls to make a GMAW (MIG) plug weld.
3. Demonstrate correct gun angle for making a plug weld using GMAW.
4. Have students complete the performance steps of the task in a safe manner.

PERFORMANCE OBJECTIVE 27

CRITERION-REFERENCED MEASURE

Questions

1. Increasing the electrode extension will cause
   a. penetration to decrease.
   b. penetration to increase.
   c. the width of the weld bead to increase.
   d. the height of the weld bead to decrease.

2. Raising the voltage while keeping the wire feed speed constant will cause which of the following?
   a. increase in arc length
   b. change in method of metal transfer
   c. decrease in weld bead width
   d. ability to make the weld on thinner metal

3. What change in the weld bead occurs when the gun angle is increased or decreased?
   a. operator's inability to see the weld
   b. smoother and wider bead
   c. higher weld bead
   d. no change

Answers

1. a.
2. a.
3. b.

Practical Application

Have students make plug weld using GMAW (MIG) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 27 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 27

MAKING PLUG WELDS USING GMAW (MIG) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Ran test bead on piece of scrap metal.		
8. Readjusted inert gas flow rate, voltage, current, wire-feed speed, and inductance.		
9. Made plug weld.		
10. Wire brushed by hand and/or ground as specified.		
11. Visually inspected weld.		
12. Performed all tasks in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 28

TASK

Make plug weld using oxyacetylene welding equipment.

STANDARD OF PERFORMANCE OF TASK

The weld must be deposited with complete fusion in both members without overlapping, cracking, porosity, or overpenetration.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Grinder
Oxyacetylene welding tips
Protective clothing
Oxyacetylene welding equipment
  (previously set up)
Welding rods
Wire brush
Work order
Workpiece

ENABLING OBJECTIVES

1. Make the proper tip selection for the thickness of the metal to be welded.
2. Use the correct method of attaching the tip to the torch body.
3. Identify the correct regulator pressures required to match tip size and metal thickness.
4. Use the correct method of lighting and adjusting the torch to a neutral flame.
5. Demonstrate safe work practices.

RESOURCES

1. Mid-America Vocational Curriculum Consortium, Inc. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 5, pp. 77-101.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Show the students how to complete the equipment check set up for oxyacetylene welding a plug weld.

TEACHING ACTIVITIES (Continued)

3. Demonstrate the proper torch angle and method of adding filler metal to a plug weld.
4. Discuss how to clean and inspect the plug weld.
5. Have the students complete the performance steps of the task in a safe manner.

CRITERION-REFERENCED MEASURE

Questions

1. Which one of the following flames is best for welding a plug weld?
   a. carburizing flame
   b. oxidizing flame
   c. neutral flame
   d. none of the above

2. The distance between the inner cone and the puddle should be
   a. 1/8 inch to 1/2 inch.
   b. 3/8 inch to 1/2 inch.
   c. 1/8 inch to 1/4 inch.
   d. 1/15 inch to 1/8 inch.

3. Distortion can be controlled by
   a. back stepping.
   b. proper tacking.
   c. clamping.
   d. all of the above.

Answers

1. c.
2. c.
3. d.

Practical Application

Have students make plug weld using oxyacetylene welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 28 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 28

MAKING PLUG WELDS USING OXYACETYLENE WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT: Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Checked work area for hazards.		
3. Selected/installed welding tip.		
4. Checked/cleaned tip as necessary.		
5. Selected welding rod.		
6. Adjusted gas pressures for welding.		
7. Put on protective attire.		
8. Rechecked positioning of workpiece.		
9. Ignited torch.		
10. Adjusted flame.		
11. Readjusted regulators as needed.		
12. Made plug weld.		
13. Brushed by hand and/or ground weld as specified.		
14. Inspected weld.		
15. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 29

TASK

Make plug weld using SMAW (arc) welding equipment.

STANDARD OF PERFORMANCE OF TASK

The weld must be deposited with complete fusion in both members without slag inclusion, overlapping, cracking, porosity, or overpenetration.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Chipping hammer
Grinder
Portable screens
Protective clothing/equipment
SMAW welding equipment (previously set up)
Weld gauge
Wire brush
Work order
Workpiece

ENABLING OBJECTIVES

1. Match terms related to SMAW equipment, application, and techniques with their correct definitions.
2. Identify equipment needed to make a plug weld using SMAW (arc) welding equipment.
3. Match techniques for plug welding with their procedures.
4. Select and correctly use basic arc welding cleaning tools.
5. Demonstrate safe work practices required in arc welding.

RESOURCES

1. Mid-America Vocational Curriculum Consortium, Inc. Student material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 11, pp. 201-225.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Show students how to correctly match polarity for electrodes to be used.
3. Demonstrate how to adjust to correct amperage by running short beads on scrap material.

PERFORMANCE OBJECTIVE 29

TEACHING ACTIVITIES (Continued)

4. Show the students the correct electrode angle, arc length, and travel speed to accurately make a plug weld using SMAW equipment.
5. Discuss the proper method of cleaning slag from a plug weld.
6. Have students complete the performance steps of the task in a safe manner.

CRITERION-REFERENCED MEASURE

Questions

1. Distortion in plug welding can be controlled by
    a. back stepping.
    b. proper tacking.
    c. clamping.
    d. all of the above.

2. Too low a current setting can result in
    a. poor arc stability.
    b. poor fusion.
    c. an incomplete flux reaction.
    d. all of the above.

3. Small diameter electrodes
    a. cannot be used on thick plates.
    b. may not get hot enough on large plates.
    c. can make acceptable welds on thick plates.
    d. are best suited for making plug welds.

Answers

1. d.
2. d.
3. d.

Practical Application

Have students make plug weld using SMAW (arc) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 29 to determine if the assignment was completed acccurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 29

MAKING PLUG WELDS USING SMAW (ARC) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT — Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR — Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked that hood had required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Ran test bead on piece of scrap metal.		
8. Readjusted voltage, current, and inductance as required.		
9. Made plug weld.		
10. Chipped stag.		
11. Wire brushed by hand and/or ground as specified.		
12. Visually inspected weld.		
13. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 30

TASK

Make plug weld using submerged-arc welding equipment.

STANDARD OF PERFORMANCE OF TASK

The weld must be deposited with complete fusion in both members without overlapping, cracking, porosity, or overpenetration.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Electrode wire
Flux
Grinder
Protective clothing
Semi-automated/automated
  submerged-arc welding
  equipment (previously
  set up)
Weld gauge
Welder's standard tool kit
Wire brush
Work order
Workpiece

ENABLING OBJECTIVES

1. Match submerged-arc welding (SAW) machine controls with their functions.
2. Match submerged-arc welding (SAW) electrical controls with their functions.
3. Match filler wire and fluxes that make a plug weld using submerged-arc welding equipment.
4. Identify basic submerged-arc welding (SAW) techniques.
5. Demonstrate safe work practices required in submerged-arc welding.

RESOURCE

Smith. **Welding Skills and Technology**, pp. 464-493.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Demonstrate how to set submerged-arc welding machine controls to make a plug weld.
3. Demonstrate correct wire feed and flux feed to make a plug weld using submerged-arc equipment.
4. Have the students complete the performance steps of the task in a safe manner.

PERFORMANCE OBJECTIVE 30

CRITERION-REFERENCED MEASURE

Questions

1. When making a plug weld with the submerged arc, the hole must be
   - a. beveled or tapered.
   - b. very small.
   - c. very large.
   - d. odd shaped.

2. When making a plug weld with the submerged arc, the electrode must be moved if
   - a. the metal gets too hot.
   - b. the hole is large.
   - c. the hole is small.
   - d. the hole is in the vertical plane.

3. When submerged-arc welding a plug weld using a thin plate and a thick plate,
   - a. a hole must be in the thick plate.
   - b. a hole must be in the thin plate.
   - c. no hole is required in the thin plate.
   - d. no hole is required in the thick plate.

Answers

1. a.
2. b.
3. c.

Practical Application

Have students make plug weld using submerged-arc welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 30 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 30

MAKING PLUG WELDS USING SUBMERGED-ARC WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Readjusted voltage, current, wire-feed rate, and flux-feed rate.		
8. Made plug weld.		
9. Wire brushed by hand and/or ground weld as specified.		
10. Recycled unfused flux.		
11. Visually inspected weld.		
12. Performed all tasks in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 31

TASK

Make plug weld using tungsten inert gas (TIG) welding equipment.

STANDARD OF PERFORMANCE OF TASK

The weld must be deposited with complete fusion in both members without overlapping, cracking, porosity, or overpenetration.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Grinder
Protective clothing
Repair/Maintenance kit #2
TIG welding equipment
(previously set up)
Weld gauge
Wire brush
Work order
Work piece

ENABLING OBJECTIVES

1. Match terms related to TIG equipment, applications, and techniques with their correct definitions.
2. Match TIG machine controls with their functions.
3. Identify equipment needed to make a plug weld using TIG welding equipment.
4. Match techniques for plug welding with their procedures.
5. Demonstrate safe work practices required in TIG welding.

RESOURCES

1. Mid-America Curriculum Consortium, Inc. Student Material.
2. Jeffus and Johnson. **Welding: Principles and Applications**. Chapter 15, pp. 293-320.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Show the students how to correctly match polarity and the type of metal to be TIG welded.
3. Demonstrate how to prepare the material for plug welding.
4. Show the students the correct torch angle and arc length required to make a plug weld.
5. Demonstrate how the filler rod is added to a plug in TIG welding.
6. Have the students complete the performance steps of the task in a safe manner.

PERFORMANCE OBJECTIVE 31

CRITERION-REFERENCED MEASURE

Questions

1. The major concentration of heat on a TIG plug is
   a. on the bottom plate.
   b. in the groove.
   c. on the top plate.
   d. not significant.

2. Excessively high shielding gas flow rates can
   a. help protect the weld.
   b. reduce oxide contamination.
   c. prevent arc blow.
   d. cause turbulence and poor weld puddle shielding.

3. Why is post welding gas flow required?
   a. to protect the hot tungsten from oxidation
   b. to protect the hot weld metal from oxidation
   c. to prevent oxides from entering the weld pool
   d. both a and b

Answers

1. a.
2. d.
3. d.

Practical Application

Have student make plug weld using tungsten inert gas (TIG) welding equipment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 31 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 31

MAKING PLUG WELDS USING TUNGSTEN INERT GAS (TIG) WELDING EQUIPMENT

Student's Name **Date**

DIRECTIONS TO STUDENT — Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR — Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Put on protective attire.		
3. Checked eye protection equipment for required lens for welding process.		
4. Checked work area for hazards.		
5. Rechecked positioning of workpiece.		
6. Turned on welding machine.		
7. Readjusted inert gas flow rate, voltage, current, and water flow.		
8. Made plug weld.		
9. Wire brushed by hand and/or ground as specified.		
10. Visually inspected weld.		
11. Performed all tasks in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 32

TASK

Braze metal components.

STANDARD OF PERFORMANCE OF TASK

The joint must be cleaned, fluxed, and brazed so that the filler metal bonds to the workpiece by entering the grain of the parent metal, then cooled slowly enough to preserve ductility. The bead must be free of cracks, undercutting, and porosity.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Filler rod
Flux
Grinder
Oxyacetylene welding equipment (previously set up)
Oxyacetylene brazing tips
Protective clothing/equipment
Sand cloth
Welder's standard tool kit
Wire brush
Workpiece
Work order

ENABLING OBJECTIVES

1. Select proper materials and equipment for welding.
2. Set up oxygen acetylene equipment for braze welding.
3. Clean and prepare material for welding.
4. Braze metal component.

RESOURCE

Giachino. **Welding Skills and Practices**. Chapter 25.

TEACHING ACTIVITIES

1. Read and discuss resource material.
2. Define braze welding.
3. Make equipment checklist.
4. Demonstrate the effects of brazing on steel.
5. Demonstrate correct technique to student.
6. Discuss cleaning process with student.

PERFORMANCE OBJECTIVE 32

CRITERION-REFERENCED MEASURE

Questions

1. Braze welding is recommended for parts to be used in high temperatures. True or False?
2. Bronze filler rod melts at _________ degrees F.
3. Allowing a small amount of molten bronze filler rod to spread over a joint is called _________.
4. If the base metal produces white smoke during braze welding, the surface is too _________.

Answers

1. False
2. 1600
3. tinning
4. hot

Practical Application

Have students braze metal components.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 32 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 32

BRAZING METAL COMPONENTS

Student's Name Date

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for weld specifications.		
2. Checked work area for hazards.		
3. Selected/installed brazing tip.		
4. Checked/cleaned tip as necessary.		
5. Selected filler rod.		
6. Adjusted oxygen and acetylene gas pressures for brazing.		
7. Put on protective attire.		
8. Rechecked positioning of workpiece.		
9. Sanded surfaces to remove grease/dirt as needed.		
10. Applied flux to surfaces as needed.		
11. Ignited torch.		
12. Adjusted flame.		
13. Readjusted regulators as needed.		
14. Heated filler rod.		
15. Dipped filler rod into flux as needed.		
16. Tinned joint as needed.		
17. Brazed metal components.		

CHECKLIST FOR PERFORMANCE OBJECTIVE 32

BRAZING METAL COMPONENTS

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
18. Packed brazed joint for slow cooling as needed.		
19. Unwrapped cooled joint.		
20. Finished brazed joint as specified.		
21. Visually inspected brazed joint.		
22. Performed all tasks in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature **Date**

DUTY PERFORMING BURNING/WELDING ACTIVITIES

PERFORMANCE OBJECTIVE 33

TASK

Silver solder (hard solder) metal components.

STANDARD OF PERFORMANCE OF TASK

The joint must be cleaned, fluxed, and brazed so that the solder flows by capillary action into the joint, providing a complete seal and/or even finish across the prescribed area.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Flux
Oxyacetylene soldering tips
Protective attire
Oxyacetylene welding equipment
  (previously set up)
Sand cloth
Solder
Workpiece
Work order

ENABLING OBJECTIVES

1. Read job specifications.
2. Select proper equipment and materials.
3. Clean, flux, and set up equipment.
4. Heat and apply solder.
5. Demonstrate safe working practices.

RESOURCES

1. Althouse et al. **Modern Welding**. pp. 204-210.
2. Jeffus and Johnson. **Welding: Principles and Practices**. Chapter 19.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Discuss characteristics of silver soldering.
3. Discuss and demonstrate the technique of silver soldering.
4. Discuss the cleaning process.

PERFORMANCE OBJECTIVE 33

CRITERION-REFERENCED MEASURE

Questions

1. A brazed joint is stronger than a soldered joint, and, in some instances, stronger than a welded joint. True or False?
2. Brazing is a relatively new process, that is, it came into use only a few years ago. True or False?
3. A neutral flame usually gives the best results in this process. True or False?
4. The smaller the silver-brazing filler metal thickness, the stronger the joint. True or False?

Answers

1. True
2. False
3. False
4. True

Practical Application

Have students silver solder (hard solder) metal components.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 33 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 33

SILVER SOLDERING (HARD SOLDERING) METAL COMPONENTS

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for soldering specifications.		
2. Checked work area for hazards.		
3. Pre-cleaned and fluxed joint.		
4. Selected/installed soldering tip.		
5. Checked/cleaned tip as necessary.		
6. Selected solder.		
7. Adjusted gas pressures for soldering.		
8. Put on protective attire.		
9. Rechecked positioning of workpiece.		
10. Ignited torch.		
11. Adjusted flame.		
12. Readjusted regulators as needed.		
13. Heated joint to approximate melting temperature of filler metal.		
14. Applied solder.		
15. Post-cleaned joint.		
16. Checked seal and finish of joint.		
17. Performed all tasks in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

PERFORMING RELATED DUTIES

DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 34

TASK

Cut material using power cut-off shears.

STANDARD OF PERFORMANCE OF TASK

Material must be cut to the prescribed dimensions without endangering the operator or others, and without damaging the equipment.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Power shears
Protective attire
Workpiece
Work order

ENABLING OBJECTIVES

1. Read and interpret blueprints.
2. Measure and lay out work before cutting.
3. Demonstrate safe work practices.
4. Cut material to proper dimensions.

RESOURCE

Althouse et al. **Modern Welding**. pp. 675-677.

TEACHING ACTIVITIES

1. Have students demonstrate ability to read blueprints.
2. Have students make equipment safety checklist.
3. Demonstrate correct technique.
4. Discuss care and maintenance of equipment.
5. Have students complete the performance steps of the task.

PERFORMANCE OBJECTIVE 34

CRITERION-REFERENCED MEASURE

Questions

1. Power shears are used in production work. True or False?
2. Power shears save money on grinding and cleaning. True or False?
3. Power shears must be used with great caution. True or False?

Answers

1. True
2. True
3. True

Practical Application

Have students cut material using power cut-off shears.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 34 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 34

CUTTING MATERIAL USING POWER CUT-OFF SHEARS

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**RATING**	
	Satisfactory	**Unsatisfactory**
1. Consulted work order for cut specifications.		
2. Checked work area for hazards.		
3. Marked material for cutting.		
4. Set back gauge.		
5. Positioned material on bed of shears.		
6, Started shears.		
7, Rechecked position of material.		
8. Inspected path of blade travel for obstructions.		
9. Cleared others from work area.		
10. Depressed cut switch while at sufficient distance from cutting action to insure operator safety.		
11. Turned off shears.		
12. Removed material from bed of shears.		
13. Cleared area of metal scraps.		
14. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 35

TASK

Cut material using power saw/abrasive wheel.

STANDARD OF PERFORMANCE OF TASK

Material must be cut to the prescribed dimensions without endangering the operator or others, and without damaging the equipment.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Power saw/abrasive wheel
Protective attire
Workpiece
Work order

ENABLING OBJECTIVES

1. Select proper material and equipment.
2. Set up equipment safely.
3. Measure and lay out work accurately.
4. Cut steel to proper size.

RESOURCE

Althouse et al. **Modern Welding**. pp 675-677.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Have students make an equipment checklist.
3. Demonstrate proper use of abrasive saw.
4. Discuss safety features.
5. Have students complete the performance steps of the task.
6. Discuss care and maintenance of equipment.

PERFORMANCE OBJECTIVE 35

CRITERION-REFERENCED MEASURE

Questions

1. Safety glasses are necessary equipment. True or False?
2. Make sure others are at a safe distance before using the abrasive wheel. True or False?
3. The abrasive wheel gives good smooth cuts. True or False?

Answers

1. True
2. True
3. True

Practical Application

Have students cut material using power saw/abrasive wheel.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 35 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 35

CUTTING MATERIAL USING POWER SAW/ABRASIVE WHEEL

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for cut specifications.		
2. Checked work area for hazards.		
3. Marked material for cutting.		
4. Clamped workpiece into position.		
5. Positioned workpiece so that kerf was on waste side of cut line.		
6. Adjusted coolant nozzle, if equipped.		
7. Inspected path of blade/wheel travel for obstructions.		
8. Cleared others from work area.		
9. Put on face shield/eye goggles as needed.		
10. Turned on power.		
11. Rechecked position of material.		
12. Adjusted flow of coolant, if in use.		
13. Made cut.		
14. Turned off power.		
15. Removed material from clamp.		
16. Cleared area of metal scraps.		
17. Performed all work in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature **Date**

DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 36

TASK

Cut pipe to length using pipe cutter.

STANDARD OF PERFORMANCE OF TASK

The pipe must be cut to the prescribed dimensions without distortion and without damage to the cutter.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Cutting oil
Pipe cutter (with reamer blade)
Workpiece
Work order

ENABLING OBJECTIVES

1. Select proper material and equipment.
2. Set up vise and secure pipe.
3. Measure and mark pipe accurately.
4. Cut to correct length.
5. Ream and remove burrs.

RESOURCES

Clifford. **The Encyclopedia of Household Plumbing**.

TEACHING ACTIVITIES

1. Discuss pipe cutting equipment.
2. Have students demonstrate correct use of pipe cutter.
3. Have students explain the proper care of equipment.
4. Discuss cleaning and use of reamer.
5. Have students complete the performance steps of the task.

PERFORMANCE OBJECTIVE 36

CRITERION-REFERENCED MEASURE

Questions

1. A pipe cutter produces a clean 90° angle cut. True or False?
2. A pencil or hacksaw may be used to mark the pipe. True or False?
3. A pipe vise will protect the pipe from damage or scars. True or False?
4. Cutting oil makes it easier to cut and prolong the life of the cutting wheel. True or False?

Answers

1. True
2. True
3. False
4. True

Practical Application

Have students cut pipe to length using pipe cutter.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 36 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 36

CUTTING PIPE TO LENGTH USING PIPE CUTTER

Student's Name **Date**

DIRECTIONS TO STUDENT — Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR — Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	**Unsatisfactory**
1. Consulted work order for cut specifications.		
2. Checked work area for hazards.		
3. Marked pipe for cutting.		
4. Opened cutter jaws.		
5. Inspected cutter and rollers for nicks.		
6. Replaced cutting wheel if nicked.		
7. Positioned cutter at cut line.		
8. Closed cutter jaws with roller pressed against pipe so that cut wheel was just touching pipe.		
9. Positioned cutter directly over cut line.		
10. Tightened cutter until light resistance to turning was encountered.		
11. Applied cutting oil.		
12. Rotated cutter around pipe.		
13. Tightened cutter 1/2 to 3/4 turn each rotation; applied cutting oil as needed until pipe was cut.		
14. Reamed ends of pipe.		
15. Performed all tasks in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

For Robert Benson: Voc. Ed.:Curriculum

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DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 37

TASK

Identify type of metal to be welded.

STANDARD OF PERFORMANCE OF TASK

The metal must be correctly classified into one of the following categories: alloy steel, low-carbon/cast steel, high carbon steel, white cast iron, gray cast iron, malleable iron, wrought iron, copper, brass/bronze, aluminum and aluminum alloys, Monel metal, nickel, or lead.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Grinder
Hammer and chisel
Heat indicator pencils
Magnet
Metal needing identification
Oxyacetylene welding equipment
Scale

ENABLING OBJECTIVES

1. Collect samples of each type of metal.
2. Select proper tools to help identify metals.
3. Identify each sample and label.

RESOURCE

Althouse et al. **Modern Welding**. Chapter 26.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Discuss each type of metal.
3. Select samples at random and have students identify.
4. Discuss uses of the different kinds of metals.
5. Have students handle and become proficient at identifying samples.

PERFORMANCE OBJECTIVE 37

CRITERION-REFERENCED MEASURE

Questions

1. Metals are classified as being either ________ or ________.
2. Different grades of steel and cast iron can be identified with good results by using the ________ test.
3. What is an alloy?

Answers

1. ferrous, nonferrous
2. spark
3. a mixture of two or more metals

Practical Application

Have students identify type of metal to be welded.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 37 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 37

IDENTIFYING TYPE OF METAL TO BE WELDED

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	**Unsatisfactory**
1. Visually inspected unknown metal.		
2. Determined if unknown metal was magnetic, slightly magnetic, or non-magnetic.		
3. Inspected chips removed from metal using cold chisel and hammer.		
4. Performed spark test.		
5. Flame tested unknown metal in conjunction with several filler metals.		
6. Weighed unknown metal.		
7. Compared weight with same size of known metal.		
8. Determined melting temperature by heating metal in conjunction with heat indicator pencil; assumed unknown metal was not a Monel, stainless, or nickel alloy.		
9. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 38

TASK

Prepare metal surfaces for welding.

STANDARD OF PERFORMANCE OF TASK

The surfaces to be welded must be free from contamination in the form of slag, scale, rust, grease, and paint; abutting surfaces must be free of moisture.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Grinder
Sand cloth
Scraper
Solvents
Wire brush

ENABLING OBJECTIVES

1. Read and interpret plans and specifications.
2. Select proper electrodes and materials.
3. Grind and repair parts for hard-surfacing.
4. Apply electrodes of fillet metal.
5. Clean grind or machine to specifications.

RESOURCE

Kennedy. **Welding Technology**. Chapter 24.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Identify and discuss electrodes and filler metal.
3. Demonstrate and make test beads on scrap metal.
4. Have students clean and prepare metal for hard-surfacing.
5. Apply hard-surfacing metal.
6. Clean to specifications.

PERFORMANCE OBJECTIVE 38

CRITERION-REFERENCED MEASURE

Questions

1. Metal parts should be cleaned and repaired before welding. True or False?
2. Surface must be clear of grease and oil. True or False?
3. It may be necessary to preheat surface. True or False?

Answers

1. True
2. True
3. True

Practical Application

Have students prepare metal surfaces for welding.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 38 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 38

PREPARING METAL SURFACES FOR WELDING

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Scraped surface of parent metal.		
2. Removed damaged metal from battered surfaces by grinding or machining.		
3. Removed irregularities from fusion faces.		
4. Degreased joint area. **CAUTION:** Use extreme caution in handling solvents. Do not use solvents near flames or arcs. Avoid inhaling fumes.		
5. Removed surface oxides from aluminum.		
6. Machined beveled surfaces where required.		
7. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 39

TASK

Secure parts for welding using clamps and fixtures.

STANDARD OF PERFORMANCE OF TASK

The parts to be welded must be secured so that they hold proper alignment within specified tolerances during welding while remaining free to expand when heated.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Welder's standard tool kit
Protective clothing
Cleats and wedges
Welding equipment
  (previously set up)
Work order
  (specifying permissible
  fit-up tolerances)
Angle bars
Clamps
Wood blocks
Workpieces

ENABLING OBJECTIVES

1. Read and interpret blueprints correctly.
2. Select proper materials and equipment.
3. Set up clamps and jigs properly.
4. Clamp parts in jig and weld.

RESOURCE

Althouse et al. **Modern Welding**. Chapter 30.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Have students make a jig and select proper clamps.
3. Cut parts to correct lengths.
4. Place parts in jig, clamp securely, and weld or tack.
5. Have students complete the performance steps of the task.

PERFORMANCE OBJECTIVE 39

CRITERION-REFERENCED MEASURE

Questions

1. Why is a jig or fixture used in welding?
2. Clamps are used to hold parts in place until welding or tacking is completed. True or False?
3. Jigs help make parts more uniform. True or False?

Answers

1. to prevent distortion and make parts more uniform
2. True
3. True

Practical Application

Have students secure parts for welding using clamps and fixtures.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 39 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 39

SECURING PARTS FOR WELDING USING CLAMPS AND FIXTURES

Student's Name Date

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order.		
2. Put on protective clothing.		
3. Brought workpieces into approximate position for welding.		
4. Marked location of required fixtures.		
5. Tackwelded fixtures into position.		
6. Applied cleats, blocks, bolts, and wedges to draw workpieces into alignment.		
7. Checked alignment against work order.		
8. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature Date

DUTY PERFORMED RELATED DUTIES

PERFORMANCE OBJECTIVE 40

TASK

Apply hard-surfacing material.

STANDARD OF PERFORMANCE OF TASK

The hard-surfacing material must be applied to the specified portions of the workpiece without porosity or irregularities, with complete fusion, and must possess sufficient cross-checking to relieve stress.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Build up electrode
Hard-surfacing electrode
Welding equipment (previously set up)
Workpiece

ENABLING OBJECTIVES

1. Read and interpret specifications.
2. Select proper electrodes for job.
3. Clean and prepare material for welding.
4. Apply electrodes or filler metal to work.
5. Clean, grind, or machine to specifications.

RESOURCE

Giachino. **Welding Skills and Practices**. Chapter 31.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Have students list hard-surfacing electrodes suitable for severe abrasions, severe impact, and moderate abrasion.
3. Demonstrate correct welding technique.
4. Discuss how to clean and inspect materials.
5. Have students complete the performance of the task.

PERFORMANCE OBJECTIVE 40

CRITERION-REFERENCED MEASURE

Questions

1. Name four industries that use hard-surfacing of metal.
2. Hard-surfacing is sometimes called __________.
3. The type of electrode is determined by ________.

Answers

1. road building, grading, construction, and farming
2. hardfacing
3. the use of the metal part

Practical Application

Have students apply hard-surfacing material.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 40 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 40

APPLYING HARD-SURFACING MATERIAL

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**RATING**	
	Satisfactory	**Unsatisfactory**
1. Consulted work order.		
2. Put on protective clothing.		
3. Positioned workpiece for welding.		
4. Selected electrodes.		
5. Preheated base metal for required soaking time.		
6. Adjusted amperage, voltage, and polarity.		
7. Built up surface to within 3/16"-3/8" of final size.		
8. Positioned workpiece so that hard-surfacing was done in flat position if possible.		
9. Applied hard-surfacing material in two layers.		
10. Induced cross-checking when required.		
11. Post-heated workpiece as required.		
12. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 41

TASK

Tack materials into position for welding.

STANDARD OF PERFORMANCE OF TASK

The parts to be welded must be tacked so that proper alignment is maintained within specified tolerances; tacks must be placed on the side of workpiece that is to be welded, in line with the joint of the specified size and spacing, and must hold the required gap between pieces.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Filler metal
Protective clothing/equipment
Spacers/Shims
Welding equipment (previously set up)
Workpiece
Work order

ENABLING OBJECTIVES

1. Select the proper clamps and jigs.
2. Set up jig and clamps for parts.
3. Place parts in jig and tack.
4. Remove for proper welding.

RESOURCE

Althouse et al. **Modern Welding**. p. 276.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Demonstrate and discuss the various types of jigs and clamps used.
3. Have students set up a jig and tack parts in position.
4. Show students how to remove parts and discuss welding.
5. Have the students complete the performance steps of the task.

PERFORMANCE OBJECTIVE 41

CRITERION-REFERENCED MEASURE

Questions

1. Why are jigs and fixtures used in welding?

2. Jigs can reduce the cost of fabricating. True or False?

3. Jigs improve the quality of parts. True or False?

Answers

1. to hold parts in place and prevent warping
2. True
3. True

Practical Application

Have students tack materials into position for welding.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 41 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 41

TACKING MATERIALS INTO POSITION FOR WELDING

Student's Name ____________________ **Date** ____________

DIRECTIONS TO STUDENT — Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR — Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	**Unsatisfactory**
1. Consulted work order.		
2. Put on protective clothing.		
3. Positioned/aligned workpiece for 'tacking, using spacers.		
4. Located tack points.		
5. Heated small triangular area until parent metal melted.		
6. Added filler metal to molten pool.		
7. Rechecked alignment and positioning of tack weld.		
8. Feathered tack, if tack was to be fully consumed by weld.		
9. Performed all work in a safe manner.		

APPROVED: YES _____ NO _____

Evaluator's Signature ____________________ **Date** ____________

DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 42

TASK

Pre and post heat carbon steel for welding using a heating torch.

STANDARD OF PERFORMANCE OF TASK

The material must be preheated to the specified temperature throughout its mass.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Oxyacetylene welding equipment (previously set up)
Oxyacetylene heating tips
Protective attire
Work order

ENABLING OBJECTIVES

1. Select proper material and equipment.
2. Determine the correctness of the finished product.
3. Set up equipment for heating and cooling.
4. Heat treat to desired hardness.

RESOURCE

Althouse et al. **Modern Welding**. Chapter 27.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Demonstrate how to heat steel until it becomes very brittle.
3, Have students heat steel and cool properly to sharpen.
4. Discuss each process with all students.
5. Have the students complete the performance steps of the task.

PERFORMANCE OBJECTIVE 42

CRITERION-REFERENCED MEASURE

Questions

1. Heat treatment does not change the metal. True or False?
2. Heat treating can relieve stress in the metal. True or False?
3. Heat treatment can change the machining qualities of the steel. True or False?

Answers

1. False
2. True
3. True

Practical Application

Have students pre and post heat carbon steel for welding using heating torch.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 42 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 42

PRE AND POST HEATING CARBON STEEL FOR WELDING USING HEATING TORCH

Student's Name **Date**

DIRECTIONS TO STUDENT — Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR — Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for preheat/postheat temperature.		
2. Checked work area for hazards.		
3. Selected /installed heating tip.		
4. Checked/cleaned tip as necessary.		
5. Adjusted gas pressures for heating.		
6. Put on protective attire.		
7. Ignited torch.		
8. Adjusted flame.		
9. Readjusted regulators as needed.		
10. Applied heat.		
11. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 43

TASK

Finish surface of weldment.

STANDARD OF PERFORMANCE OF TASK

The weldment should be ground flush with the surface of the parent metal and provided with the prescribed degree of smoothness.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Abrasive disks
Grinder
Polishing compound
Protective attire/equipment
Work order
Workpiece

ENABLING OBJECTIVES

1. Select proper grinder and safety equipment.
2. Set up work for cleaning.
3. Identify proper method for cleaning.
4. Clean or grind properly.

RESOURCE

Giachino. **Welding Skills and Practices**. Chapter 4.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Discuss the effects of grease, dirt, and other foreign matters on welding.
3. Have students clean and prepare metal for welding.
4. Demonstrate the correct way to use a grinder and other power equipment.
5. Have students complete the performance steps of the task.

PERFORMANCE OBJECTIVE 43

CRITERION-REFERENCED MEASURE

Questions

1. Grease and dirt do not affect the welding. True or False?

2. Rust and dirt can be removed with a grinder. True or False?

3. Use extreme care when using torch to remove paint or other coatings. True or False?

Answers

1. False
2. True
3. True

Practical Application

Have students finish surface of weldment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 43 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 43

FINISHING SURFACE OF WELDMENT

Student's Name Date

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order for specifications.		
2. Checked work area for hazards.		
3. Secured workpiece.		
4. Put on protective clothing.		
5. Installed grinding disk with required abrasiveness.		
6. Ground weldment.		
7. Polished surface as required.		
8. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature Date

DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 44

TASK

Locate cracks using "magnaflux" techniques.

STANDARD OF PERFORMANCE OF TASK

Any cracks in the weldment must be identified by inducing magnetic field perpendicular to the crack line. After the cracks are located, the workpiece must be demagnetized.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Black light
Magnetic dusting powder (flourescent)
Portable magnetic-particle testing unit
Work order
Workpiece

ENABLING OBJECTIVES

1. Select proper material and equipment.
2. Set up magnetic power supply.
3. Create a magnetic field with test prods.
4. Observe and identify cracks.

RESOURCES

1. Althouse et al. **Modern Welding**. Chapter 28.
2. Sacks. **Welding Principles and Practices**. Chapter 37.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Discuss magnetic fields.
3. Discuss power supply and flux.
4. Demonstrate and locate cracks in steel or cast iron.
5. Have students complete the performance steps of the task.

PERFORMANCE OBJECTIVE 44

CRITERION-REFERENCED MEASURE

Questions

1. Magnetic particle testing requires which of the following?
    a. a radiographic machine
    b. a high-amperage electrical current
    c. a doctor's stethoscope
    d. a magnifying lens

2. The magnetic particle test cannot be used on austenitic stainless steels. True or False?

3. Surface cracks can be located with magnetic particle testing. True or False?

Answers

1. b.
2. True
3. True

Practical Application

Have students locate cracks using "magnaflux" techniques.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 44 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 44

LOCATING CRACKS USING "MAGNAFLUX" TECHNIQUES

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order.		
2. Checked work area for hazards.		
3. Secured workpiece.		
4. Dusted weld with magnetic dusting powder.		
5. Induced magnetic field across/along weldment.		
6. Observed where dusting powder failed to accumulate. **NOTE:** Magnetic powder will distribute and accumulate evenly and heavily along a crack .		
7. Rechecked, using black light.		
8. Demagnetized workpiece.		
9. Performed all work in a safe manner.		

APPROVED: YES ____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 45

TASK

Pressure test the weldment.

STANDARD OF PERFORMANCE OF TASK

Any leaks in the weldment must be identified by observing where pin holes or cracks allow water to escape from the vessel while under pressure.

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Pressure gauge
Pressure pump
Water/inert gas/compressed air supply
Work order
Workpiece

ENABLING OBJECTIVES

1. Read and interpret plans and specifications.
2. Select proper tank, gauges, and equipment.
3. Fill tank to proper pressure for testing.
4. Insert tank in water.
5. Release air and clean for proper use or shipping.

RESOURCE

Kennedy. **Welding Technology**. Chapter 27.

TEACHING ACTIVITIES

1. Have students read and discuss resource material.
2. Have students define pressure testing.
3. Demonstrate how to test gauge for accuracy.
4. Install gauge.
5. Demonstrate putting proper pressure in tank.
6. Have students release air and clean up tank.

PERFORMANCE OBJECTIVE 45

CRITERION-REFERENCED MEASURE

Questions

1. A tightness test is nondestructive testing. True or False?
2. If the container is leaking it will not have a pressure drop. True or False?
3. If the container is submerged in water the leak will show up as bubbles. True or False?

Answers

1. True
2. False
3. True

Practical Application

Have students pressure test weldment.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 45 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 45

PRESSURE TESTING WELDMENT

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	Unsatisfactory
1. Consulted work order.		
2. Checked work area for hazards.		
3. Secured workpiece.		
4. Connected pump.		
5. Closed off other ports.		
6. Introduced water/inert gas/air.		
7. Brought up to pressure with pump.		
8. Checked for leaks.		
9. Shut off pump and water flow.		
10. Released pressure.		
11. Disconnected pump.		
12. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

DUTY PERFORMING RELATED DUTIES

PERFORMANCE OBJECTIVE 46

TASK

Shape steel beams.

STANDARD OF PERFORMANCE OF TASK

The beam must be brought into the prescribed shape by heating only small portions of its total surface area at no time hotter than "bright red."

SOURCE OF STANDARD

Writing team of incumbent workers

CONDITIONS FOR PERFORMANCE OF TASK

Oxyacetylene welding equipment (previously set up)
Oxyacetylene heating tips
Protective attire
Structural beam
Work order

ENABLING OBJECTIVES

1. Read and interpret plans and specifications.
2. Select material and tools to measure and lay out work.
3. Set up cutting equipment.

RESOURCE

Kennedy. **Welding Technology**. Chapter 12.

TEACHING ACTIVITIES

1. Have the students read and discuss resource material.
2. Discuss proper ways to set the torch flame.
3. Explain how to shape scrap metal until it is done proficiently.
4. Have students shape steel beam without overheating it.
5. Have students complete the performance steps of the task.

PERFORMANCE OBJECTIVE 46

CRITERION-REFERENCED MEASURE

Questions

1. What causes metal to rust?
2. The size of the cutting tip used depends on the thickness of the material to be cut. True or False?
3. If the welder moves too quickly the kerf will close up behind the torch. True or False?

Answers

1. oxygen in the air
2. True
3. False

Practical Application

Have students shape steel beams.

Method of Evaluating Practical Application

Use Checklist for Performance Objective 46 to determine if the assignment was completed accurately.

CHECKLIST FOR PERFORMANCE OBJECTIVE 46

SHAPING STEEL BEAMS

Student's Name **Date**

DIRECTIONS TO STUDENT Prepare the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	RATING	
	Satisfactory	**Unsatisfactory**
1. Consulted work order for camber specifications.		
2. Checked work area for hazards.		
3. Selected /installed heating tip.		
4. Checked/cleaned tip as necessary.		
5. Adjusted oxygen and acetylene pressures for welding.		
6. Put on protective attire.		
7. Rechecked positioning of workpiece.		
8. Marked spots to be heated.		
9. Ignited torch.		
10. Adjusted flame.		
11. Readjusted regulators as needed.		
12. Heated marked spots.		
13. Checked shape of beam after cooling.		
14. Repeated spot heating to readjust shape of beam.		
15. Performed all work in a safe manner.		

APPROVED: YES _____ NO ____

Evaluator's Signature **Date**

APPENDICES

APPENDIX A

DUTY/TASK LIST

APPENDIX A

DUTY/TASK LIST

DUTY/TASK	PO/PAGE NO.
A - SETTING UP WELDING EQUIPMENT	
Set up air-carbon arc cutting/gouging equipment.	01/5
Set up GMAW (MIG) welding equipment.	02/8
Set up oxyacetylene cutting/welding equipment.	03/12
Set up oxygen-arc cutting/gouging equipment.	04/18
Set up plasma-arc cutting/welding equipment.	05/22
Set up SMAW (arc) welding equipment.	06/26
Set up submerged-arc welding equipment.	07/29
Set up GTAW (TIG) welding equipment.	08/32
B - PERFORMING BURNING/WELDING ACTIVITIES	
Burn (cut) material using hand-held torch.	09/37
Burn (cut) material using mechanized traveling/track torch equipment.	10/41
Weld pipe using GMAW (MIG) welding equipment.	1145/
Weld pipe using oxyacetylene welding equipment.	12/48
Weld pipe using SMAW (arc) welding equipment.	13/51
Weld pipe using submerged-arc welding equipment.	14/55
Weld pipe using tungsten inert gas (TIG) welding equipment.	15/59
Make fillet weld using GMAW (MIG) welding equipment.	16/63
Make fillet weld using oxyacetylene welding equipment.	17/66
Make fillet weld using SMAW (arc) welding equipment.	18/69
Make fillet weld using submerged-arc welding equipment.	19/72
Make fillet weld using tungsten inert gas (TIG) welding equipment.	20/75
Make full penetration weld using GMAW (MIG) welding equipment.	21/78
Make full penetration weld using oxyacetylene welding equipment.	22/81
Make full penetration weld using plasma-arc welding equipment.	23/85
Make full penetration weld using SMAW (arc) welding equipment.	24/88
Make full penetration weld using submerged-arc welding equipment.	25/92
Make full penetration weld using tungsten inert gas (TIG) welding equipment.	26/95
Make plug weld using GMAW (MIG) welding equipment.	27/98
Make plug weld using oxyacetylene welding equipment.	28/101
Make plug weld using SMAW (arc) welding equipment.	29/104
Make plug weld using submerged-arc welding equipment.	30/107
Make plug weld using tungsten inert gas (TIG) welding equipment.	31/110

DUTY/TASK	PO/PAGE NO.
Braze metal components.	32/113
Silver solder (hard solder) metal components.	33/117
C - PERFORMING RELATED DUTIES	
Cut material using power cut-off shears.	34/121
Cut material using power saw/abrasive wheel.	35/124
Cut pipe to length using pipe cutter.	36/127
Identify type of metal to be welded.	37/130
Prepare metal surfaces for welding.	38/133
Secure parts for welding using clamps and fixtures.	39/136
Apply hard-surfacing material.	40/139
Tack materials into position for welding.	41/142
Pre and post heat carbon steel for welding using a heating torch.	42/145
Finish surface of weldment.	43/148
Locate cracks using "magnaflux" techniques.	44/151
Pressure test the weldment.	45/154
Shape steel beams.	46/157

APPENDIX B

DEFINITIONS OF TERMS

APPENDIX B

DEFINITIONS OF TERMS

A number of terms frequently used in this guide may be unfamiliar to the reader; others may be familiar, but in the context of this handbook they have been assigned special meanings.

AFFECTIVE.
Skills which emphasize an attitude, feeling, emotion, or degree of acceptance and rejection.

CATALOG.
A comprehensive collection of performance objectives, performance guides, and related data developed in a specific domain.

CBVE (COMPETENCY - BASED VOCATIONAL EDUCATION).
A methodology of instruction that (a) identifies the abilities and skills needed for on-the-job performance; (b) informs students and teachers of the precise and detailed learning objectives required to achieve these competencies; (c) emphasizes performance standards in testing, course requirements, and/or graduation; and (d) facilitates learning by letting each student master the task prior to advancing to another.

CHECKPOINT.
A point in the development of the V-TECS product when material must be sent to V-TECS central office for quality review.

CIP (CLASSIFICATION OF INSTRUCTION PROGRAM) CODE.
A code developed by the U.S. Office of Education to identify a specific cluster of related jobs for training program identification.

COGNITIVE.
Skills which emphasize the recall of knowledge and development of intellectual abilities.

COMPETENCY.
Proficiency in the knowledge and skills required of workers in a particular occupation or occupational specialty; a term used by educators to mean program goal, duty, task, or objective. In some cases the terms are essentially synonymous.

CONDITIONS.
Describes the situation for competent task performance, including tools and equipment to be used, and limitations under which the task will be performed.

CONSORTIUM.
A group of state agencies, institutions, or other entities which have been legally constituted through letters of commitment, agreements, or by assignment of higher authorities to work together toward the solution of problems in education. A consortium, for the purposes of this work, must have membership from autonomous agencies and institutions which cut across state boundaries as they attempt to solve problems or meet goals.

CRITERION-REFERENCED MEASURES.
An evaluative procedure used to determine if a student has mastered a performance objective.

CROSS-REFERENCE TABLE.
A table that identifies the relationship among duties and tasks found in the occupational inventory and the performance objectives in the final catalog. Also noted are percentages of incumbents performing the tasks by D.O.T.

CURRICULUM GUIDE.
An instructional resource developed from a V-TECS catalog to guide CBVE for an occupation.

DICTIONARY OF OCCUPATIONAL TITLES (D.O.T.).
A document published by the U.S. Department of Labor, Employment and Training Administration. This publication groups occupations into systematic occupational classification structures based on interrelationships of job tasks and requirements.

DISTRACTOR.
An incorrect response to a multiple-choice or true/false test item.

DOMAIN (OCCUPATIONAL DOMAIN).
A group of job titles that are related on the basis of required skills and knowledge.

D.O.T. CODE.
A nine-digit number used to identify a specific job within a given calendar year.

DUTY.
A cluster of related tasks performed by incumbent workers in an occupational domain.

ENABLING OBJECTIVE.
An objective related to background knowledge or skills that are prerequisite to the mastery of a given task.

FIELD REVIEW.
The process of using and refining drafts of V-TECS materials for the purpose of identifying content errors or technical problems.

GUIDE SHEET.
Instructional information including the duty, performance objective, tasks, performance of standard, survey of standard, conditions for performance of tasks, enabling objectives, resources, teaching activities, criterion-referenced measures, and performance guide.

JOB.
A group of tasks performed by a job incumbent.

JOB INCUMBENT.
An individual who is currently employed in an occupation.

OCCUPATIONAL ANALYSIS (Task Analysis).
The process of reviewing elements of a job for the purpose of improving training program content across program levels of vocational-technical education.

OCCUPATIONAL INVENTORY (Task Inventory Booklet).
A survey instrument listing tasks performed and tools and equipment used by job incumbents in an occupational domain.

OCCUPATIONAL SURVEY.
The procedures for collecting data to identify the duties and tasks that comprise one or more jobs, job types, or career field ladders for the collection and analysis of information concerning such duties.

O.E./CIP CODE.
A code developed by the U.S. Office of Education to identify a specific cluster of related jobs for training program identification.

PERFORMANCE-BASED INSTRUCTION.
Instruction which requires the learner's demonstration of specific competencies. The desired abilities are selected before the instruction is described and are clearly defined as observable performance objectives.

PERFORMANCE CHECKLIST.
A list of performace steps derived from the performance guide to record acceptable or unacceptable performance of each step of a task.

PERFORMANCE GUIDE (PG).
A series of steps required for performance of a task arranged in the sequence ordinarily followed.

PERFORMANCE OBJECTIVE (PO).
A statement, in precise measurable terms, of a particular behavior to be exhibited by a learner under specified conditions, including a standard of performance.

PSYCHOMOTOR.
Skills which emphasize manipulation of material or tools.

QUALITY REVIEW.
A review of content by V-TECS staff or designated representative to examine quality of content, format, and style of V-TEC product(s).

RESOURCES.
Materials which are used to develop instruction and/or learner-specific objectives.

SOURCE OF STANDARDS.
A person or origin from which the information establishing the standard is received.

STANDARD.

The criteria used to determine if a task has been successfully or unsuccessfully performed.

STATE OF THE ART REFERENCE.

Current materials from which information or resources can be found to facilitate instruction.

STATE OF THE ART (SOA) STUDY.

Research conducted to determine the current status of performance-based instructional materials and practices in the domain area under study and obtain other information that might be useful in catalog development.

SUBJECT-MATTER EXPERT.

A highly experienced person (incumbent worker/instructor) who assists in identifying task performance steps, skills, and knowledge necessary to perform the job.

TASK.

A unit of work activity which constitutes logical and necessary steps in the performance of a duty. A task has a definite beginning and ending point in its accomplishments and generally consists of two or more definite steps.

TASK ANALYSIS.

The process of reviewing elements of a job for the purpose of improving training program content across program levels of vocational technical education.

TASK LIST.

A list of tasks performed by incumbents in a specific occupation domain.

TEACHING ACTIVITIES.

Methods and/or procedures for delivering instructional content to students.

TEST-ITEM BANK.

A collection of criterion-referenced test items coded for input and retrieval by computer or manual methods.

VALIDATION.

The process of assuring that all aspects of an occupational task analysis identify the skills, knowledge, and attitudes performed in the occupation.

VERIFICATION.

The procedure of collecting data to substantiate an existing product; for example, task list verification.

V-TECS.

An acronym representing: Vocational-Technical Education Consortium of States; 795 Peachtree Street, N.E., Atlanta, Georgia 30365. A consortium of states that provide competency-based, vocational-technical education materials while conserving time and money through shared development and dissemination.

V-TECS CATALOG.
An incumbent-based description of the duties, tasks, performance objectives, peformance guides, and related data in a specified occupation.

WORKING CONDITIONS.
The atmospheric and environmental conditions under which a worker performs a specific job.

WRITING TEAM.
A team of people representing instructors with subject matter expertise; persons having knowledge and experience in developing criterion-referenced measures; local or state supervisors in the domain being developed; workers and supervisors of incumbent workers whose function is to analyze occupational data and develop performance objectives for specific D.O.T. areas.

APPENDIX C

TOOLS/EQUIPMENT/WORK AIDS

APPENDIX C

Tools/Equipment/Work Aids by Percent Incumbents Using

N = 131

Tools/Equipment/Work Aids	Percentage of Members Using	Number of Members Using
Gloves, Welding	100.0	131
Helmet, Welding (Hood)	93.9	123
Lighter, Friction (Striker)	93.1	122
Brush, Wire	91.6	120
Marker, Soapstone	91.6	120
Cleaner Set	91.6	119
Cutting Torch, Oxyacetylene	90.8	119
Regulator, O2 (Oxygen Gauge)	90.1	118
Regulator, Fuel Gas (Acetylene Gauge)	90.1	118
Electrodes, Welding (Rods)	90.1	118
Clamp, Vise Grip	89.3	117
Clamp, "C"	89.3	117
Rule, Flexible Steel Tape	89.3	117
Face Shield	87.0	114
Hammer, Chipping	87.0	114
Grinder, Portable	82.4	108
Hammer, All-Steel (3 lb.)	82.4	108
Hammer, Ball Peen	82.4	108
Goggles, Welding	81.7	107
Square, Combination	80.9	106
Cylinder, Gas	80.2	105

Tools/Equipment/Work Aids	Percentage of Members Using	Number of Members Using
Tip, Cutting	80.2	105
Sledgehammer	79.4	104
Hose Assembly, Twin-Fitted (Oxyacetylene)	78.6	103
Clamp, Bar	77.1	101
Files (Assorted)	77.1	101
Pliers, Straight Nose	75.6	99
Compresser, Air	74.0	97
Hoist, Electric Chain	73.3	96
Rule, Steel 12-Inch	72.5	95
Hacksaw, Hand	71.0	93
Jack, Hydraulic	67.9	89
Hearing, Protection	67.2	88
Sleeves, Leather	66.4	87
Square, Framing	65.6	86
Grinder, Pedestal	64.9	85
Flux	64.9	85
Torch, Oxyacetylene	64.1	84
Pliers, Needle Nose	61.8	81
Bandsaw, Power (Stationary)	61.1	80
Apron, Welding	58.8	77
Grinder, Pencil (Air)	57.3	75
Hammer, Soft Face	56.5	74
Cutting Torch, Carbon Arc	55.7	73

Tools/Equipment/Work Aids	Percentage of Members Using	Number of Members Using
Compass, Layout	55.0	72
Dividers, Layout	54.2	71
Chisel, Impact	52.7	69
Tank, O_2 Storage	51.9	68
Cutting Machine (Track/Traveling)	41.8	63
Cutting Attachment, Circle Guide	45.8	60
Bake Oven (Electrodes)	45.0	59
Mallet, Rubber	43.5	57
Cap, Hard (Safety)	42.7	56
Crayon, Heat (Temp Stick)	42.7	56
Shear, Power	42.7	56
Anvil	42.0	55
Grinder, Belt	42.0	55
Clamp, Chain	41.2	54
Cutter, Pipe	41.2	54
Leak Test Solution	41.2	54
Rule, Circumference	41.2	54
Grinder, Surface	40.5	53
Flowmeter	39.7	52
Dresser, Abrasive Wheel	38.2	50
Nipper, End Cutting	38.2	50
Cutter, Bolt	35.9	47
Iron Working Machine	35.9	47
Mallet, Rawhide	35.9	47
Tip, Scarfing (Flush)	35.1	46

Tools/Equipment/Work Aids	Percentage of Members Using	Number of Members Using
Bandsaw, Portable	34.4	45
Beltsander, Portable	34.4	45
Block and Tackle	34.4	45
Hacksaw, Power	34.4	45
Hood, Leather Welding	34.4	45
Power Source, DC (Engine Drive)	34.4	45
Reamer, Pipe	34.4	45
Respirator	32.1	42
Nibbler (Portable Shear)	32.1	42
Scaler, Needle	28.2	37
Tank, Liquid Storage	26.7	35
Grinder, Die	24.4	32
Quenching Tank	24.4	32
Tongs, Pickup	23.7	31
Parallels, Adjustable	22.9	30
Shear, Squaring	22.9	30
Shoespats, Leather	20.6	27
Knee Pads	18.3	24
Shear, Alligator Jaw	18.3	24
Cutting Torch Plasma (Arc)	16.0	21
Metal Identification Kit	15.3	20
Tongs Curved Lip	15.3	20
Hardness Tester (Rockwell)	14.5	19
Oven, Heat Treating	14.5	19
Grinder, Tungsten Electrode	13.7	18

Tools/Equipment/Work Aids	Percentage of Members Using	Number of Members Using
Pipe Beveling Machine	11.5	15
Tensile Testing Machine	9.2	12
Guided Bend Tester	5.3	7
Shear, Splitting	5.3	7

APPENDIX D

SOURCE OF STANDARDS

APPENDIX D

SOURCE OF STANDARD

Writing Team of Incumbent Workers

APPENDIX E

STATE OF THE ART LITERATURE

APPENDIX E

STATE OF THE ART LITERATURE

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APPENDIX F

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